STREET RAILWAY FARES

THEIR RELATION TO LENGTH OF HAUL AND COST OF SERVICE

REPORT OF INVESTIGATION CARRIED ON IN THE RESEARCH DIVISION OF THE ELECTRICAL ENGINEERING DEPARTMENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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PREFACE

The contents of this book comprise data collected and conclusions reached in a research on electric railway traffic and fares, which research has been performed at the Massachusetts Institute of Technology. The data of street railway traffic and fares were broadly investigated for many years back, and were carried up to the immediate present. The subdivisions of the main problem taken up comprise the major factors of street railway traffic which influence the cost of carrying the average passenger and the manner in which these factors affect the practicability of making long hauls for five cents in ordinary street railway service.

The data point strongly to certain limitations in regard to fares and hauls, which are intimately associated with the density of traffic, measured either in revenue passengers carried per car-mile run or in passengers carried per year per mile of main track. The exposition has been made with the aid of tables and charts, so that the data and conclusions may be readily available to street railway officials, municipal officers and publicists.

In view of the fact that the wages of labor and the prices of materials have been radically changed as a consequence of the European war, the data set forth in this publication and the conclusions stated in the publication do not include any consideration of conditions after January, 1916. Of course the abnormal war conditions (including the enhanced interest rate for money, besides the changed labor conditions and material markets) must be taken into account if it is desired to apply the conclusions to the present year, but it is believed that the data and conclusions are presented in such a fashion that they will be valuable as a guide in street railway management even under the extraordinary circumstances into which the country is plunged by the war. It is to be observed that the research was not wholly limited to the conditions in this country, but also took up conditions in foreign countries; but here again conditions after January, 1916, have not been included in the compilation.

The more important subdivisions of the subject dealt with have been treated in separate chapters, and it is believed that this subdivision into chapters will make the book more valuable to students of street railway problems.

It is customary to publish in pamphlet form as Research Bulletins, the results of electrical engineering researches made at the Institute, but the importance to a large number of electric railway officials and to innumerable street railway passengers of the material in this publication, made it desirable to publish it in book form available for more general distribution. This book becomes Bulletin No. 14 of the Electrical Engineering Research Division of the Massachusetts Institute of Technology.

The Authors.

Cambridge, Mass.,
August, 1917.

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CHAPTER I

SUMMARY AND CONCLUSIONS OF THIS RESEARCH

About the middle of the year 1913, the Research Division of the Electrical Engineering Department of the Massachusetts Institute of Technology was authorized and endowed with funds to conduct a research upon the economics of the street railway industry with particular reference to the alleged inadequacy of the 5-ct. fare under present conditions of rising prices and wages, and also with reference to the length of ride given for this fare.

Since formulating in 1914 a syllabus of the problem to be investigated, the Research Division has carried on its researches continuously with all engineering data and statistics available in the department and from time to time has solicited suggestions and advice from street railway men and public officials in various parts of the country. It is a pleasure to state that nearly every railway company and public commission from which information was sought gave freely and generously of any material available.

This investigation has been conducted during the years 1914–15–16. In the first part of 1914 it was conducted under the direction of Professor Harold Pender but thereafter under the direction of Professor Jackson. One research assistant (Mr. McGrath) has been employed continuously on this piece of work, and others, Mr. Schurig, Mr. Buell and Mr. Bowler, have been employed part of the time.

The general features of the history of the electric traction industry in the United States have been reviewed. Statistics of past and present conditions have been obtained and masses of general information and miscellaneous data have been secured by an extensive review of the literature and reports available and by personal interviews with street railway officials, members of public service commissions and public utility experts. This study has not been confined to any particular place or territory, but naturally the most accessible material was that relating to eastern street railways, and particularly those in Massachusetts. Many of the larger cities east of the Mississippi River have been visited and their transportation conditions investigated. Some information has been obtained from as far west as the Pacific Coast, and a statistical comparison has been made between costs and conditions of operation in British and American municipalities previous to European changes caused by the war.

General Nature of Factors Connected with Street Railway Research.—This investigation differs materially from the type of physical or chemical research which ordinarily comes to the attention of the engineer or the scientist. It is largely a problem in economics, but there are certain sociological and psychological factors which, combined with the fact that local conditions play a large part in the way in which street railways develop, tend to make this kind of problem a most difficult and complex one with which to deal, and a problem for which there can be no absolutely universal and general solution.

The best that can be done by such an investigation as this is to determine all the facts of importance relating to the question of fares and length of haul, to draw from them such broad and general conclusions as may be warranted, to make general recommendations for what seems to be the best method or methods of developing in the future, and to indicate what modifications specific local conditions may introduce.

Specific Facts Established.—As a result of the studies made during the course of this research, there have been brought out certain fundamental facts which have a more or less direct bearing on the question of proper rates of fare. Some of these facts have heretofore been matters of dispute in the absence of sufficient and accurate data to establish conclusively the existence of the facts. These specific facts for which the supporting data will be found in subsequent chapters, may be stated briefly as follows:

1. Density of traffic is the most fundamental factor in establishing the cost of service per passenger. The higher the density of traffic, the lower the investment charges and operating expenses *per passenger*. In this connection density of traffic is a term used to mean passengers carried per car-mile run, and passengers carried per mile of track per annum.

2. Longer hauls tend to *decrease* density of traffic, thus decreasing the earnings per car-mile, and increasing the cost per passenger.

3. The average length of passenger haul *increases* with the *length of line.*

4. The density of traffic becomes large in medium-sized cities, but as the cities spread out and become very large, the density of traffic tends to decrease again because of long hauls into thinly settled suburbs.

5. Increased unit fares have a tendency to decrease traffic, while decreased unit fares tend to increase traffic.

6. For a number of individual roads studied, as well as for the aggregate of all street railways in Massachusetts combined statistically as a single system, it has been found that the average actual investment per revenue passenger carried per annum has been increasing, and the average rate of return has been decreasing. This has been associated in the last few years with an upward tendency of operating cost per revenue passenger.

7. Fares in British cities are somewhat lower than on American street railways, and are almost invariably based upon the distance the passenger rides. In general they approximate about 1 ct. (U. S. money) per mile and the average ride is usually only about 2 miles. Lower rates abroad may be ascribed partially to a greater density of traffic which results from a much greater density of population per mile of track, while wage scales are much lower in British cities than in this country and free transfers between lines are seldom issued.

General Conclusions.—As might naturally be expected, it has been found quite impossible to determine any fixed standard of costs or fares per passenger or per passenger-mile which can be universally applied to all street railways. Some street railways have been found in the past to be very profitable at 5-ct. fares while others are clearly unable to earn a fair return upon investment and give good service at this rate to their present traffic. A great many must be classed as doubtful, that is, a special and an extensive investigation of each particular company would be required before one could say decisively whether or not their revenues are inadequate at present rates of fare.

The general conclusion arrived at from a study of all the facts and data which have been collected is a somewhat revolutionary one. Briefly stated it is that the flat-rate fare system as used on practically all of the street railway lines in this country as an inheritance from the horse-car days, is not now the proper or the best system for the present and the probable future street railway conditions. It is in many cases inadequate (at 5-ct. rates) to meet the total cost of good service, it is too inflexible to meet changing conditions in the costs of labor and material or to provide for an increasing average length of haul, and it is discriminatory between long and short riders. In view of the facts and data brought out and supported in subsequent chapters, it appears that the only reasonable, just and generally satisfactory way to take proper care of present conditions and to prepare for future conditions is for the street railways to revise their fare systems on a basis more nearly approximating distance or zone rates. The system need not be an exact mileage rate, nor even duplicate the European method of very short stages, but some modification of fares involving the element of distance is becoming increasingly necessary.

A reasonable limitation of the length of haul for the 5*-ct. fare in city service with small excess fares for long hauls will accomplish this purpose. It may be more fully accomplished by* 3*-ct. fares in more closely restricted lengths of haul, but the difficulties of fare collection and auditing are increased.*

Quality of Service.—It is generally assumed that the public wants *good service*, and in a great many cases it is not now getting it. It must be remembered, however, that the total cost of good service must in the end be paid by the public. No company can long live to sell good service unless it is receiving an adequate revenue for it. The public dissatisfaction with street railway service is plainly justified in certain cities and on certain suburban lines. Such poor service, however, may not be the street railway company's fault. It may be due to the inadequacy of the existing rate of fare, or to other causes for which the particular company may or may not be responsible.

Throughout this report it is understood that a grade of service completely satisfactory to the public is an ideal to be approached as nearly as is possible under the practical limitations imposed by the necessity for keeping to a reasonably low rate of fare and with due consideration for the diversity of human nature.

Investment and Rate of Return.—It is not necessary in a report of this nature to deal at any length with the rights of investors to a return on their money. It has been thoroughly established by the Supreme Court's basic decision[1] and a multitude of subsequent decisions of many courts and public service commissions that public utilities are entitled to a "fair return on the fair value of property used and useful" in serving the public. There

[1] Smythe *vs.* Ames, 169 U. S., 466.

are a great many shades of opinion as to just what constitutes "fair value," and a "fair rate of return." It is generally admitted, however, that a bona fide cash investment, honestly and prudently made and maintained, should receive a rate of return sufficiently high to prove attractive enough to cause additional capital to be furnished whenever it is needed for the development, extension or improvement of the existing utility.

No particular rate of return can be fixed as representing a universally "fair" standard. Local conditions, the general condition of the money market, competition of other industries for the use of capital, the comparative security or risk and the method of taxation involved, all affect the rate of interest at which money may be secured. In certain parts of this report an average rate of 7 per cent. return on investment is assumed for purposes of illustration. "Fair" rates are frequently set somewhere between 6 and 8 per cent., but each particular situation must be judged on its own merits.[1]

In all parts of this report dealing with investment and capitalization, every possible effort has been made to include only those data which represent actual cash (or equivalent) investment in street railway property. No capitalizations have been accepted as evidence of investment, or value, except where engineering valuations have been available, or where commission regulation has limited the capitalization to the actual cash investment.

In general, it is a self-evident economic fact that the more investors are made certain of the continuous and uninterrupted receipt of interest and dividends, the lower will be the average rate they will be willing to accept. Stock issues which depend for dividends solely upon the net income which may remain after all other charges are met, and are given no additional guarantee or security, can only be sold when accompanied by the possibility of a relatively high maximum rate of return. On the other hand bonds secured by mortgage issued against street railway property sell in the open market at prices to yield about 5 per cent. interest, and in the East many well-established companies can sell mortgage bonds at prices which return approximately this rate. However, mortgage bonds usually command

[1] List of important decisions on rate of return appended at end of this chapter.

this advantageous rate only when the total value of property covered by the mortgage is so much greater than the face of the mortgage that the owners of the mortgaged property (*i.e.*, the corporation and its stockholders) must still have a large personal interest in the property, unless there is some additional security, such as the principal and the rate of return being guaranteed by the public.

A fare system, possessing sufficient flexibility to decrease the risks of loss of dividends or interest, will enable street railways to obtain capital at minimum rates. In Cleveland, Ohio, where, by arrangement with the public, fares are based on a sliding scale so as to practically guarantee a return of 6 per cent. on the par value of the company's stock, additional issues of stock have been sold at a premium of several dollars per share. In the earlier history of the Boston Elevated Railway Co., when the stock was receiving regular 6 per cent. dividends, with a fair margin of surplus, the stock sold at one time as high as $190 per share.[1] Today, the company's credit is impaired by heavy financial burdens and the stock, which is earning about 5 per cent., is selling on the market below par. These are particular examples, but they serve to illustrate the general principle involved.

General Summary of the Street Railway Fare Problem.—In addition to the most important specific facts and conclusions set forth in the preceding paragraphs, the situation may be summed up briefly as follows:

1. The street railway is a private enterprise, granted monopoly privileges by the public and in return it owes the public good service at reasonable rates, such rates to be adjusted so as to be fair to all users of the service, and sufficient to allow the owners of the railway a fair and just return upon their investment. These owners are just as much a part of the public as the car-riders, and are entitled to just treatment and equal protection by the laws, and no more.

2. Many companies are not earning a fair return at the present time, others are obviously making ample earnings. A great many in between these extremes may be classed as doubtful, that is, each would require a special investigation to determine its actual condition.

3. Practically all street railways have continued to operate upon a 5-ct. fare basis, despite increased costs of investment and operation, and despite increases in the length of ride offered for the 5-ct. fare.

[1] Tax exemptions on railway stocks in Massachusetts made an apparently safe 6 per cent. stock a very desirable one.

Public opinion and authority have been largely instrumental in causing the continuance of this system.

4. The 5-ct. fare has been not only a convenient unit, but it has probably aided to some extent in the healthy expansion of city areas. Nevertheless, it puts a high rate per mile upon the short riders for the benefit of the long riders. If costs of operating street railway service continue to increase, increased fares will become inevitable, and if 6-, 8- and even 10-ct. flat rates are resorted to, the inequality between long and short riders will become intolerable.

5. Some attempts have been made already to meet increased costs by increasing unit fares to 6 cts. or more. It is clearly shown by data submitted with this report that increased unit fares almost invariably result in a reduction in total passenger traffic. Short riding is discouraged if not entirely eliminated by higher unit fares. So far, no city system of importance has yet experimented with 6-ct. fares.

6. It seems impossible, as a practical matter, to accurately correlate the cost of service with varying lengths of ride, and as a matter of fact, the length of each individual ride and the exact cost thereof are relatively unimportant. The main controlling factor in the average cost of service per passenger is density of traffic. This factor, in turn, is more or less directly influenced by the length of haul and other factors.

7. While it seems impracticable to allot the exact share of the complex costs of street railway service to varying lengths of ride, it would be both impracticable and inexpedient to base rates wholly upon the exact cost of each service, even if it were known; but some approximation to costs should be attempted in the rates.

8. Goods or products are almost always sold at a total price depending upon the quantity involved, subject, of course, to certain modifications and classifications. Transportation on the street railways is a product and should be subject to the same economic law. Passenger rates on the steam railroads are based on mileage rates of 2 to 3 cts., with certain reasonable reductions for multiple-trip or monthly tickets and for very long trips.

9. To meet increasing costs of service and to *properly prepare for extensions* of existing systems, the street railways in the United States, both urban and suburban, will sooner or later be forced to adopt a system of rates based more nearly on the length of haul. A mileage system of rates is probably not desirable in American cities. It may be desirable in certain cities to retain the nickel fare by putting a reasonable and proper limit on the length of ride permitted for that rate, but, in general, something shorter and more uniform than our present irregular and unsystematic 5-ct. zones must be adopted, possibly with lower unit rates than 5 cts. A minimum or initial fare of 5 cts. may perhaps be retained in certain cases, but there is some evidence

to support the opinion that *reasonably limited* city areas may be served at less than 5 cts.[1]

10. Every individual street railway presents a special problem in itself and must be studied separately before detailed recommendations as to proper rates of fare can be made. After the purely financial and economic sides of the question have been investigated, a full and thorough consideration must be given to the possible effect on sociological conditions of any change in rates or systems of fares and quality of service, and also to the psychological aspects, that is, the possible effect on the minds and feelings of the public at large, since the public must be depended upon for the financial success or failure of any public utility enterprise.

Scope of This Report.—In the following chapters of this report, statistics and discussions are presented in support of the specific facts and general conclusions which have been summarized in this chapter. General methods are outlined for revising fare systems so as to limit the length of ride for the 5-ct. fare to its proper or "economic" length, and the possibility of installing a practical low-fare system adapted to the ordinary conditions in American cities is suggested.[2]

Court and Commission Decisions on "Fair Rate of Return."—The following cases illustrate several of the more important decisions of courts and commissions in this country on specific percentages of return on investment.

ELECTRIC RAILWAY CASES

1898. U. S. Circuit Court in Milwaukee Electric Railway & Light Co. *vs.* City of Milwaukee, held that a return of only 4½ per cent. of the actual investment would be confiscatory.

1911. Nebraska Railway Commission in its decision on the application of the Lincoln Traction Co. for an advance in rates of fare, held that 8 per cent. is not excessive.

1911. Railroad Commission of Washington in case of Puget Sound Electric Railway Co., held that 7 per cent. might be considered as a fair return and even 6 per cent. might not be confiscatory.

[1] Several middle Western and certain Eastern cities are actually enjoying street railway service at fares of less than 5 cts. While the results are not generally wholly satisfactory, either financially or from the point of view of good service, they might be made so by placing greater restrictions on the length of haul for the low fare and charging slightly higher rates for longer trips.

[2] A proposed method for securing low fares for restricted city districts is suggested in connection with the discussion of determining the economic limit of haul for the single fare, in Chapter XIII.

1911. Railroad Commission of Georgia in Savannah Electric Co. fare case, held that an existing rate of 6.77 per cent. earned on the fair value of the property is not excessive nor sufficient to justify a reduction of fares.

1912. Railroad Commission of Wisconsin in case of City of Milwaukee *vs.* Milwaukee Electric Railway & Light Co., holds that a rate of 5 to 6 per cent. interest plus 1½ to 2 per cent. for profits, based on the fair "earning value" of the property is fair. About 7½ per cent. on the "earning" value is the usual amount adopted by this Commission in street railway cases (see 1915 Supreme Court of Wisconsin case, cited below).

1914. New Hampshire Public Service Commission in Manchester fare case based its decision against reduced fares on 6 per cent. as a fair return.

1914. Massachusetts Public Service Commission in Middlesex & Boston Street Railway fare case, held that the average dividends (on stock issued under Massachusetts laws) of only 4.35 per cent. were inadequate. Stated that 5 to 6 per cent. is absolutely necessary to bring the stock up to par. (Note.—Stock of Massachusetts street railways has always been tax-exempt in Massachusetts.)

1914. New York Public Service Commission, 2d District, in the Schenectady fare case, held that 8 to 9 per cent. was not an excessive return under present conditions and dismissed the petition for reduced fares.

1915. New York Public Service Commission, 2d District, in the Rochester fare case, stated that 6 per cent. would be considered a minimum fair return, while an existing average rate of 8.58 per cent. was not deemed excessive.

1915. New Jersey Public Utility Commission in case of the application for increased fares by the Trenton & Mercer County Traction Corporation, found that during the 4 preceding years an average of 9.4 per cent. had been earned, but renewals of the plant and equipment had been somewhat neglected. After proper allowances had been made there still remained a net revenue of 7.37 per cent., which was held to be sufficient. Advance in rates not permitted.

1915. Supreme Court of Wisconsin in case of Duluth Street Railway *vs.* Railroad Commission of Wisconsin, *re* fares fixed by the Commission in the City of Superior, held that 7½ per cent. average return is fair.

STEAM RAILROAD CASES

1897. Minnesota Supreme Court, in Steenerson *vs.* Great Northern R. R. Co., held that a rate as low as 2½ per cent. on value of terminal lands, and 5 per cent. on other railroad property would not be confiscatory.

1903. U. S. Circuit Court in case of rates fixed by the Florida Railroad Commission for the Louisville & Nashville R. R. Co., held that the minimum "fair" rate would be the legal rate of interest in that State.

1908. Pennsylvania Supreme Court in Pennsylvania Railroad *vs.* Philadelphia County, states that the legal interest rate in Pennsylvania (6 per cent.) would be the minimum fair return while higher rates might also be fair.

1908. U. S. District Court in the case of Central Railway of Georgia *vs.* Railroad Commission of Alabama, held that rates fixed so as to give the company less than the legal rate of interest (8 per cent.) are unjust.

1909. U. S. District Court in St. Louis and San Francisco R. R. Co. *vs.* Hadley, decided that a 6 per cent. return on the allowed valuation would be fair.

1909. Interstate Commerce Commission in Spokane *vs.* Northern Pacific Ry., held that a 4 per cent. return would be insufficient.

1911. U. S. Circuit Court in Shepard *vs.* Northern Pacific Railway in Minnesota, held that a net return of 7 per cent. on the value of property devoted to transportation is fair.

1911. U. S. Circuit in Arkansas Rate Cases, decided that in ordinary years there should be 6 per cent., plus 1½ per cent. to provide for poor years.

CHAPTER II

DENSITY OF TRAFFIC—THE MOST VITAL FACTOR IN AVERAGE COST OF SERVICE PER PASSENGER

Volume of Business and Prices in the Street Railway and Other Industries.—The various items which go toward making up the total cost of street railway service naturally vary considerably on different street railways, due to the influence of a great many different factors. Standards of construction and equipment are different in different localities, wage scales are higher in some places than in others, large companies purchasing great quantities of materials frequently obtain them at more favorable unit prices than small companies, and tax systems and rates are also subject to some variation. The extent of these variations, while considerable, is not as great as might be expected at first thought. There are certain reasonable limits within which the several items of expense, reduced to some unit basis, are usually found to vary.

The one factor which most vitally affects the cost of service per passenger, and consequently the proper rate of fare, is the number of passengers carried per unit of track in a unit of time, or the number per unit of operation. This factor is generally recognized in the street railway business under the name of density of traffic. It is analogous to the factor which the manufacturer or the merchant recognizes in his business as volume of production or of sales. The manufacturer or the merchant, who with a certain plant or establishment makes or sells twice as many goods as another concern with an equivalent plant or establishment, can make lower prices to his patrons and at the same time secure larger profits for himself.

The difficulties of many, if not all economically managed ordinary street railways which are unsuccessful financially can be expressed in terms of lack of sufficient density of traffic at existing rates to support the investment and necessary costs of operation. The apparently simple remedy of raising rates upon the existing traffic is always the first to be suggested when additional revenue is desired, but experience has shown in many cases that increased flat rates result in a loss of traffic and consequently mean a still lower density of traffic. Lack of sufficient density of traffic may be due to one or more of a great many factors, such as giving too long a ride for the 5-ct. fare, or operating in territory where the population is too sparse to support a railway. In the early days of the electric railway, optimistic promoters built lines in country districts which have not yet become sufficiently populated to make the transportation system profitable, yet these lines have furnished a service and means of communication which has been of immense economic and social value to these communities. The risk of lack of returns on investment is one which the early promoters and investors took upon themselves, but in view of the actual value of the service rendered by their initiative and sacrifice, it would seem distinctly unfair to limit their returns to savings bank rates at a later date when the traffic begins to become profitable.

The Measurement of Density of Traffic.—In the street railway industry, density of traffic is most commonly and conveniently measured in terms of:

1. Number of revenue passengers carried per mile of single main track per annum.
2. Number of revenue passengers carried per passenger-car-mile.

There is no absolutely fixed relation between these two units. Of two roads which have the same number of revenue passengers per car-mile, one may carry a larger number of passengers per mile of track per annum than the other. In general, a high density of traffic in terms of the first unit will also be high in terms of the second, but it is not universally so. The general relation, as nearly as any relation exists, is shown in Fig. 1. It appears that when the number of revenue passengers per mile of track per annum is very small, the number per car-mile is usually small. The number of passengers per car-mile increases very rapidly at first, with small increases in the number of passengers per mile of track, and then appears gradually to approach a fairly constant average. This may probably be ascribed to the fact that in the larger cities, the number of revenue passengers per mile of track is higher than in the small ones because of greater population density, but the number of passengers per car-mile is limited by the capacity of the car, and by longer hauls.[1]

[1] See Chapter III, "Relation of Length of Haul to Density of Traffic and Cost of Service."

In this report, the *car-mile unit* is used as the fundamental basis of analysis where *density of traffic* is concerned, as it appears to be the more significant index. In some instances, however, supplementary analyses have been made on the basis of "revenue passengers per mile of single main track per annum."

The curve, as drawn in Fig. 1, represents approximately the average location of the points representing the traffic density on 35 street railways for which we have the data. It is evident from the

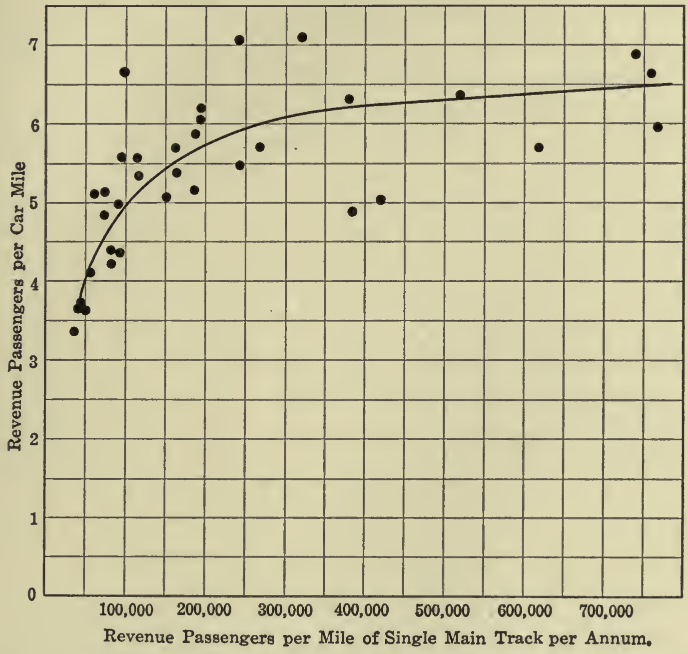

Fig. 1.—Density of traffic. Relation of passengers per car mile to passengers per mile of track (35 different companies).

"gunshot" nature of the plot that the data for any particular system may fall considerably above or below this average curve. Differences in capacity of cars, standards of service, and length of haul all tend to cause deviations from the average curve.

In considering this plot, and all other statistical plots as presented in this report, it must be remembered that curves are drawn to represent average conditions, and the deviation of the statistics of some few particular systems from the average does not necessarily mean that something is wrong. In a number of the following plots, curves have been drawn to represent what is termed "ordinary maximum" and "ordinary minimum" conditions, that is, they are so plotted as to include in the area between them practically all of the data except a few plainly sporadic points, and at the same time they are drawn so as to conform to the direction and shape of the average curve. The space between such curves may be considered as the "ordinary" range of variation of the item under consideration.

Factors Affecting Density of Traffic.—There are so many different factors and conditions in the street railway business which influence or limit the density of traffic that it is impossible to give an adequate discussion of them in a report of this nature. Standard text-books dealing with the economics of the location, construction and operation of railways deal quite extensively with this subject.

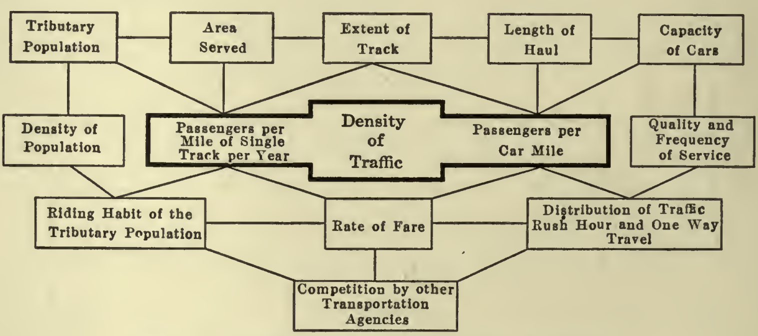

FIG. 2.—Factors influencing density of traffic.

In order to bring to mind the more important of these many factors without giving any extended discussion of them, Fig. 2 has been prepared to illustrate diagrammatically some of the factors, something of their mutual interrelation and to show what form of density of traffic they most directly affect. If it is desired to learn why any particular street railway has a greater number of passengers per car-mile or per mile of track than another street railway, due consideration must be given to all of these factors. In the succeeding chapter it is shown that longer hauls will in general reduce the average number of passengers per car-mile, but this in turn may be partially offset by a difference in the capacity of the cars, or the frequency of service.

Greater Density of Traffic Means Lower Average Cost per Passenger.—A study of the statistics of investment, operating expenses and density of traffic of a number of street railways indicates that there is a reasonably well-defined and consistent relation between density of traffic and cost of service. The number of companies of which really reliable data on the actual investment or value of property have been obtained is rather limited, but insofar as satisfactory data have become available, they seem to show that, as the density of traffic increases, there is a decrease of the investment per revenue passenger carried per annum and of the operating expenses per revenue passenger carried.

Relation of Investment to Density of Traffic.—While it is plain that no absolutely fixed statistical standard of investment in street railways can exist, it has been found that there is fairly definite decrease in the investment per revenue passenger carried per year, as the number of revenue passengers carried per car-mile increases. Investment data of 35 operating street railway systems have been included in this study. The majority are Massachusetts companies, where for many years the capitalization of street railways has been subject to Commission regulation under anti-stock-watering laws, and where, as a consequence, the book values of permanent property may reasonably be supposed to represent actual cash (or equivalent) investment. Outside of Massachusetts, only such railway investments as have been checked by engineering appraisals have been included.

The investment per revenue passenger carried per annum is a unit of comparison which has been developed in the course of this research. It is derived by dividing the total investment up to and including any particular year, by the number of revenue passengers carried during that year.[1]

The relation between the investment per revenue passenger carried per annum and the density of traffic in passengers per car-mile is shown in Fig. 3. The position of the so-called ordinary maximum and minimum curves is to some extent arbitrary. They were laid out in such a manner as to include between them practically all of the data and possess the general form of the

[1] This unit is described and discussed in an article entitled "Investment per Revenue Passenger," by D. J. McGrath, in the *Electric Railway Journal*, May 8, 1915. An additional article by the same author, July 8, 1916 entitled "Investment per Revenue Passenger and Density of Traffic," explains something of the relationship shown here.

average curve of the data (not shown) and at the same time to keep within a moderate range of variation. Only 5 of the 35 points lie without the indicated range. Two of these lying below the minimum curve represent companies without power plants. If power plants were owned by these companies, the data would be nearer to, if not over the line. One of the points slightly above the maximum curve represents a company operating a system of rapid transit subway and elevated lines in connection with the

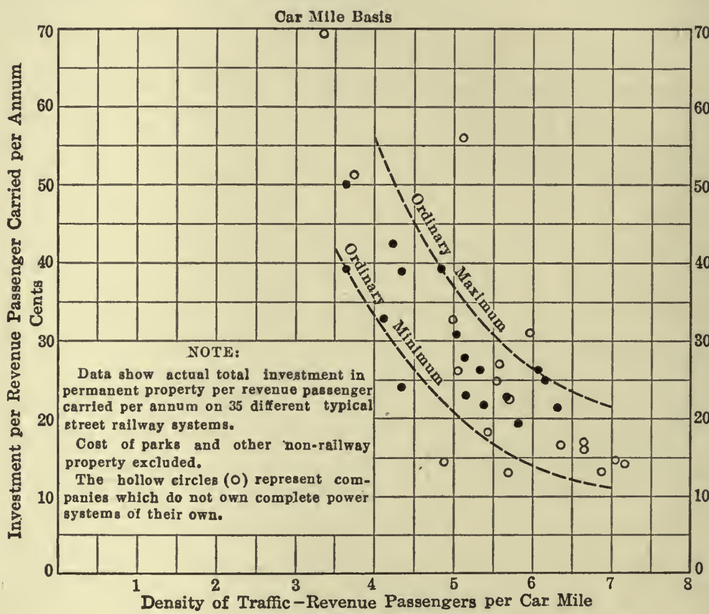

FIG. 3.—Relation between investment and density of traffic.

surface lines, and the high cost of such special construction makes the data very high on the plot. No satisfactory explanation has been found for the other two abnormal points.

It appears as if the investment per revenue passenger would reach a final minimum at a density of about 8 revenue passengers per car-mile, but as no densities higher than 7.1 were actually found among the available data, it is unsafe to attempt to predict beyond the range shown on the plot.

Return on Investment and Density of Traffic.—If some average percentage rate of return may be assumed as generally "fair," say 7 per cent. per year for purposes of illustration, then it must be evident that the amount required per passenger to pay such a rate will decrease as the density of traffic increases, since the actual investment per passenger follows this relation. Bas-

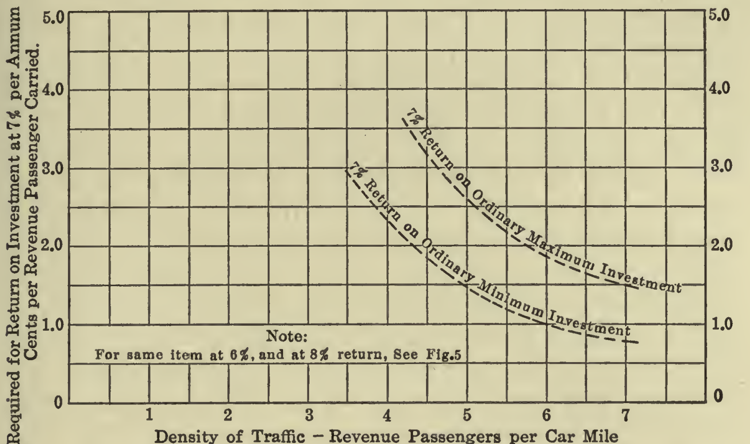

FIG. 4.—Relation between density of traffic and the amount required for return on investment per revenue passenger, assuming an average return of 7 per cent. on the range of investment shown in Fig. 3.

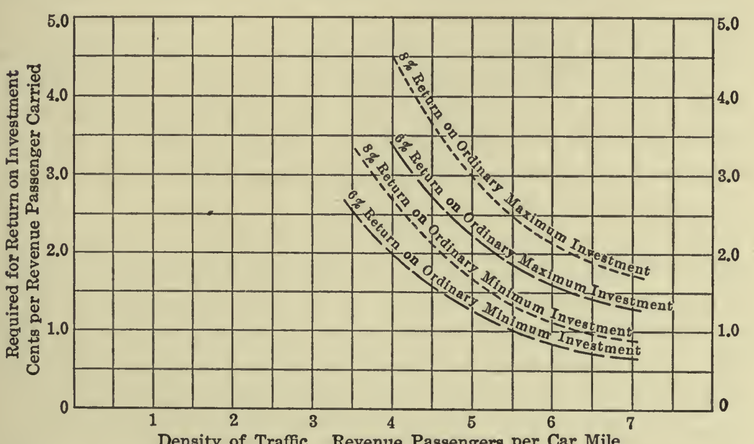

FIG. 5.—Relation between density of traffic and the amount required for return on investment per revenue passenger, assuming average rates of 6 and 8 per cent. on the range of investment shown in Fig. 3.

ing the average amount (in cents) for return on investment required per revenue passenger carried per annum on the ordinary range of investment per revenue passenger shown in Fig. 3, a pair of curves have been plotted (Fig. 4) to show the ordinary maximum and minimum range of this item at 7 per cent. on the investment and at different traffic densities. For any other rate of return the curves would merely be shifted proportionately higher or lower on the scale. Examples at 6 and 8 per cent. are shown on Fig. 5.

Relation of Operating Expenses[1] to Density of Traffic.—In spite of wide variations in the costs of individual items comprising the total operating expenses, it has been found that there is a certain degree of correspondence in the operating expenses per car-mile of the majority of street railways, and that furthermore, there is a corresponding tendency toward a decreasing operating expense per revenue passenger carried, as the number of revenue passengers per car-mile increases. Some of the individual items which go to make up the total operating expenses are almost completely independent of the car-miles run. Such, for instance, are advertising expenses, salaries of general officers, paving maintenance, etc. Other items are more closely related to other units than car-miles, and only indirectly related to the car mileage. One example of such an item is the compensation of motormen and conductors, which is usually paid on an hourly basis. The renewal of ties which may be worn out by the passing of cars, but which are ordinarily renewed because of general decay due to the action of the elements, is another example.[2] Nevertheless, the car-mile unit has always been a convenient and popular one, and an analysis of the expenses of a large number of street railways shows that practically all are operating at from 16 to 23 cts. per revenue car-mile.

Of the 35 companies for which investment data were obtained, as described above, data of the operating expenses were available for 34, and all but 8 of these fell within the limits of 16 to 23 cts. per car-mile. Of the 5 which were more than 23 cts. per car-mile, 4 had special circumstances which made them abnormal, such as exceptionally high depreciation charges, high rates for

[1] Any actual charges for renewals or for depreciation reserves have been included here with operating expenses, but no attempt has been made here to set any standard for these items.

[2] For a description of the various units of comparison most applicable to individual items of expense, see "Statistical Units Used in Analysis of Electric Railway Accounts," by J. A. Emery, 1913 *Proceedings American Electric Railway Accountants Association.* See also "Cost of Urban Transportation Service," Chapter VII, by F. W. Doolittle.

purchased power, or unusual wage scales. The 3 which were less than 16 cts. per car-mile appeared to have rather low maintenance charges. The data used in preparing the curves in this Bulletin were mostly derived from 1914 reports. *In view of the present rate of increase in prices of materials and wages to labor, there is some question as to whether any companies can continue to operate and provide adequately for maintenance and depreciation at* 16 *cts. per car-mile or even more.* The statistics of the present year may show that a higher "ordinary minimum" will have to be used.

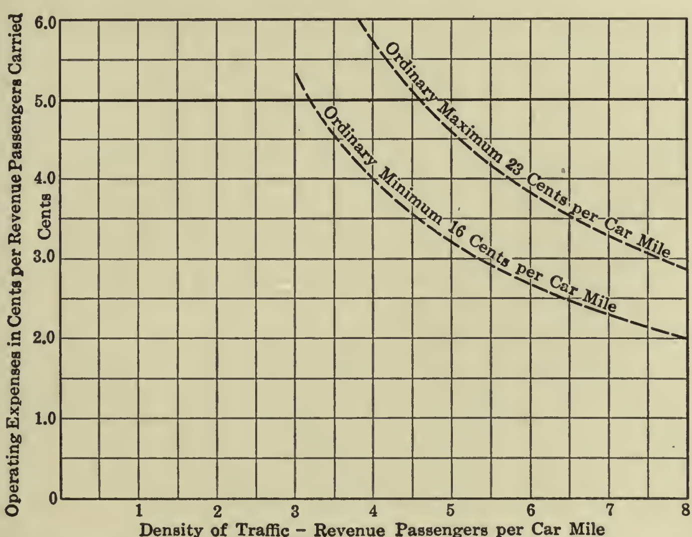

FIG. 6.—Relation of operating expenses per passenger to density of traffic.

The operating statistics show that the ordinary type of street railway may have from about 4, or a little less, to 7, or a little more, revenue passengers per car-mile run, depending, of course, on the factors previously mentioned.

Evidently, with operating expenses at, say 16 cts. per car-mile, and with 4 revenue passengers per car-mile, the average op.erating expense per revenue passenger carried will be $\frac{16}{4}$ or 4 cts, while under the same expense conditions, if 7 revenue passengers are carried, the average will be only $\frac{16}{7}$ or 2.29 cts. per passenger. At higher operating expenses per car-mile, the per passenger figures will be proportionately higher, but the same proportion of decrease will be shown as the density of traffic increases. This is shown graphically in Fig. 6, where 16 cts. and 23 cts. per car-

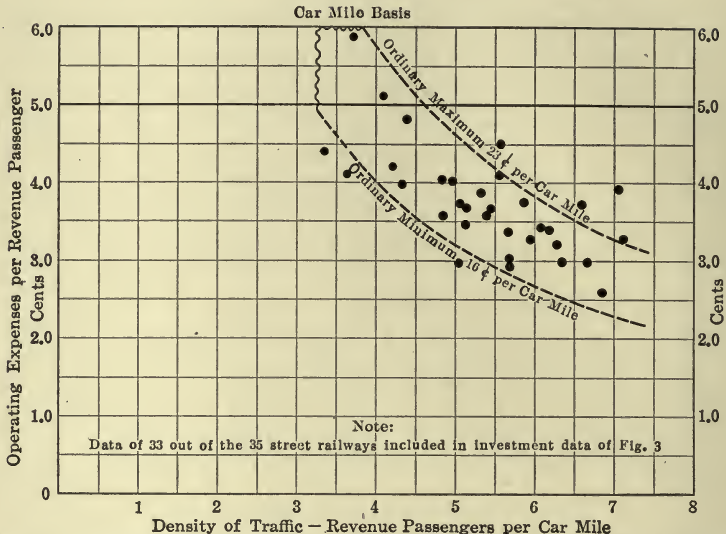

FIG. 7.—Relation of operating expenses per passenger to density of traffic.

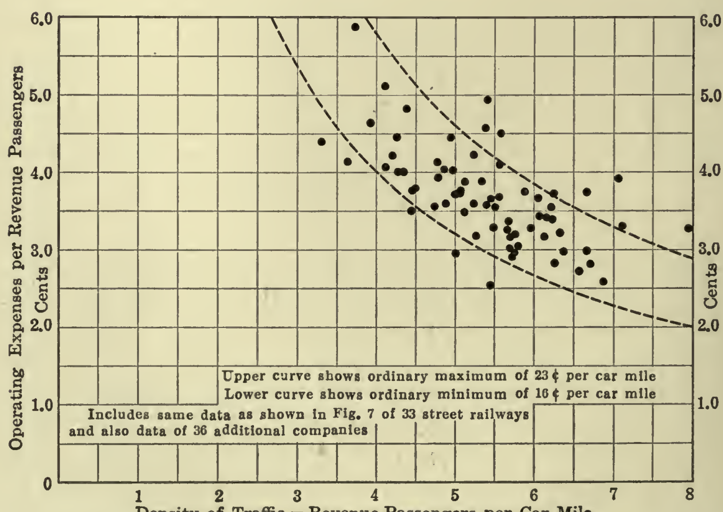

FIG. 8.—Relation of operating expenses per passenger to density of traffic. (Supplementing Fig. 7.)

mile are taken as representing the ordinary minimum and maximum operating expenses of street railways. In Fig. 7 is shown the distribution of the actual data of the 34 companies[1] and it will be observed that all except 8 of them lie within the range of 16 to 23 cts. per car-mile.

In order to check these data as to their general application, operating statistics from a number of roads in addition to these 34 have been secured, and Fig. 8 has been plotted. It is similar to Fig. 7, except that it is made up from a much larger collection of data. It appears to agree fairly well with the average conditions of density of traffic and operating expenses as shown by the more limited collection of data from the 34 companies.

It is to be hoped that in the course of time, more data of actual investments in street railway properties will become available so that the conclusions as to decrease of investment per revenue passenger with increasing density of traffic may be also further checked and the range of variation confirmed or properly modified if necessary.

Taxes.—The item of taxes seems to bear little or no relation to the density of traffic. While the expense for taxes is a very material one, and one which bears heavily on many struggling companies, it is relatively small as compared with the total operating expenses and return on investment. Taxes may occasionally require as low as 0.1 ct. per revenue passenger and in a few cases they are more than 0.4 ct. per revenue passenger. As a general condition, however, 0.2 ct. may be regarded as an ordinary minimum and 0.4 ct. as an ordinary maximum per revenue passenger.

Relation of Total Cost of Service to Density of Traffic.—By adding the "ordinary minimum" operating expense curve of Fig. 7, plus minimum taxes of 0.2 ct. per revenue passenger, and the curve of the "ordinary minimum" return at 7 per cent. on investment of Fig. 4, there results a curve shown in Fig. 9, which may be said to represent the "ordinary minimum" total cost of service. In a similar way the curve representing the "ordinary maximum" total cost of service per revenue passenger is obtained. The shaded space between the maximum and minimum curves indicates the range of variation which may be expected in the total cost of street railway service per revenue

[1] One of the 34 is not shown on Fig. 7 because it fell beyond the range of the plot.

passenger, under ordinary conditions, bearing in mind that it is based on a 7 per cent. average return per year on actual investment. For purposes of illustration, two other charts have been prepared from the same data used in obtaining the preceding plots, but based on a 6 per cent. and an 8 per cent. average rate of return. These are Fig. 10 and Fig. 11 respectively. A com-

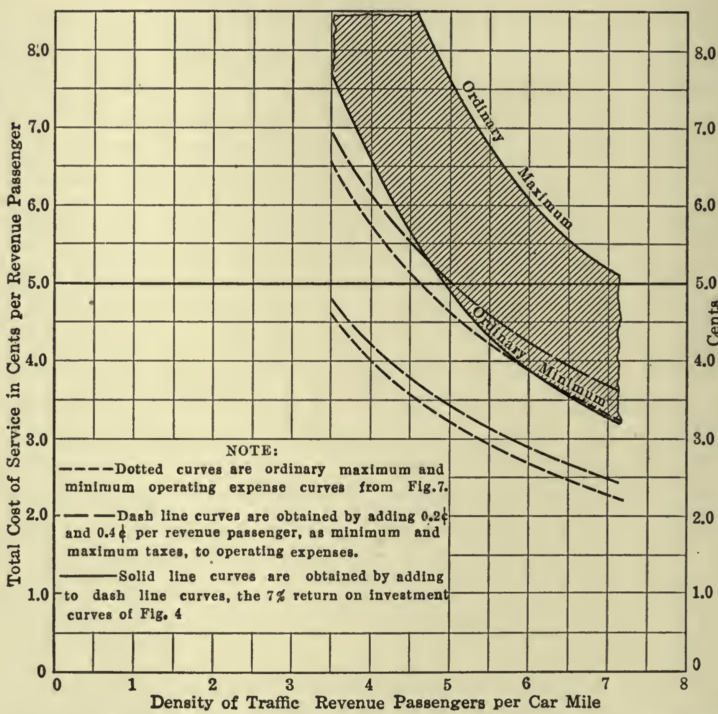

FIG. 9.—Ordinary range of total cost of service per revenue passenger. On basis of a 7 per cent. average return on ordinary range of investment. (Dotted lines represent ordinary maximum and minimum operating expense curves. Dash lines are obtained by adding 0.2 and 0.4 ct. per revenue passenger, as minimum and maximum taxes, to the operating expense curves.)

parison of the positions of the curves for these three different rates of return, indicates that there is not more than 0.2 or 0.3 ct. difference per passenger between a return of 6 per cent. and 7 per cent. or 7 per cent. and 8 per cent., at medium and high traffic densities.

The range between the minimum and maximum curves on these total cost of service charts probably represents very nearly an extreme range, rather than an "ordinary" range. Although they are made up of the sums of "ordinary minimum" and of "ordinary maximum" curves, it would be somewhat unusual for a company to have all three elements, investment, taxes, and operating expenses, a minimum or a maximum at the same time.[1]

Relation of Total Cost of Service to Density of Traffic, Using the Mile of Track Unit Density.—It was stated in the preliminary

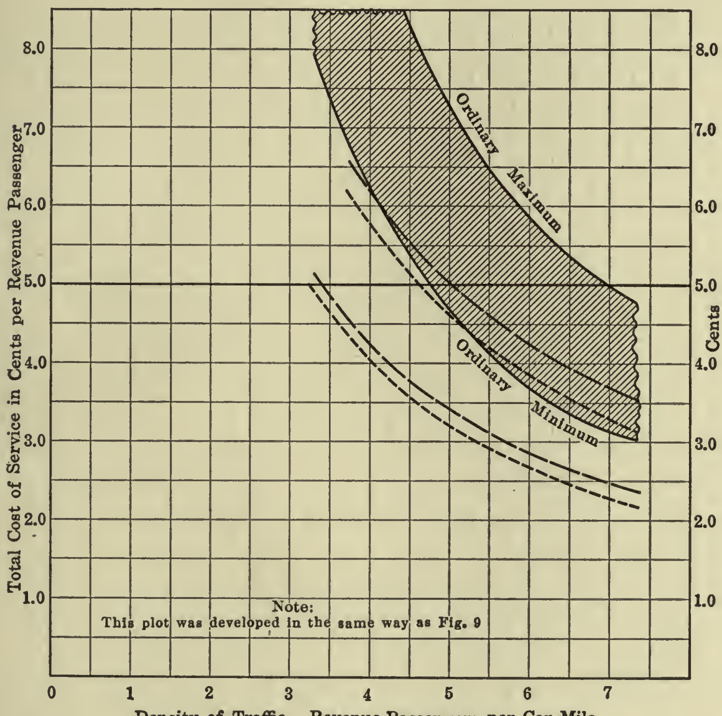

FIG. 10.—Ordinary range of total cost of service per revenue passenger. On basis of a 6 per cent. average return on ordinary range of investment.

discussion of density of traffic that the unit of "revenue passengers per car-mile" was considered the more significant index for comparisons and statistical work, but that the other unit, "revenue passengers per mile of single main track per annum," would also be used for illustrative and supplementary purposes.

[1] For instance, a company might have a very low investment without owning any power plants, but the extra cost of purchased power would probably increase operating expenses somewhat above the minimum.

An approximate general relation between the two units was shown in Fig. 1. This general relation is reasonably well substantiated by Fig. 12, which contains all the data of Fig. 1, and a great many additional data. The curve is slightly changed, but since the change is trifling, and since the fundamental principles are being worked out on the basis of the original 35 roads, Fig. 1 will be considered correct, and used herein.

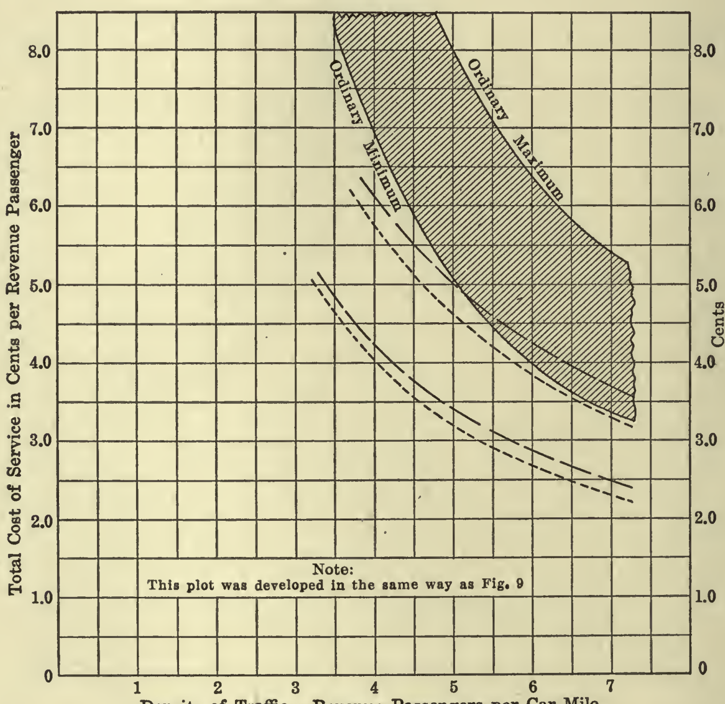

Fig. 11.—Ordinary range of total cost of service per revenue passenger. On basis of an 8 per cent. average return on ordinary range of investment.

On the basis of this supplementary density unit, Figs. 13 to 16 have been prepared. In these charts the range of variation of total cost of service per revenue passenger has been developed in the same manner as in the preceding discussion of the car-mile density unit, and the data of the same 34 roads have been used.

The location of the so-called ordinary maximum and minimum curves on these plots has been made to conform with the loca-

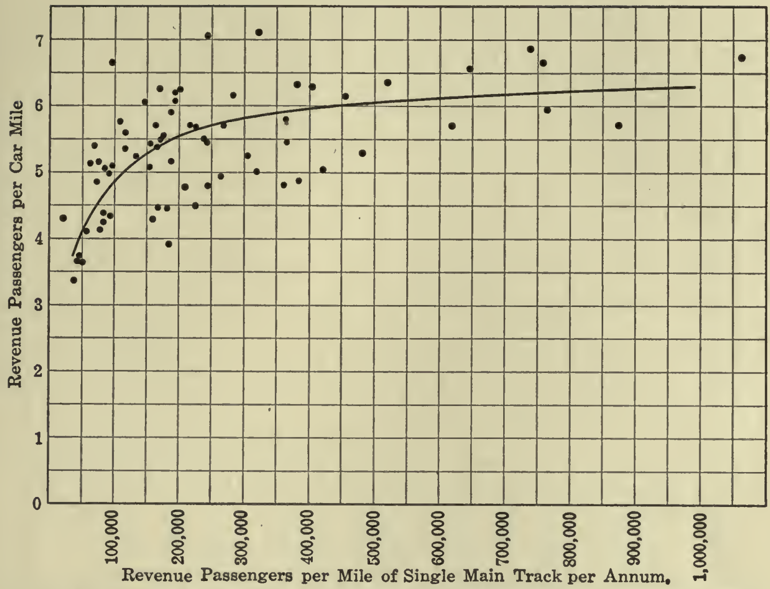

FIG. 12.—Density of traffic. Relation of passengers per car mile to passengers per mile of track. (Same as Fig. 1, but with additional data.)

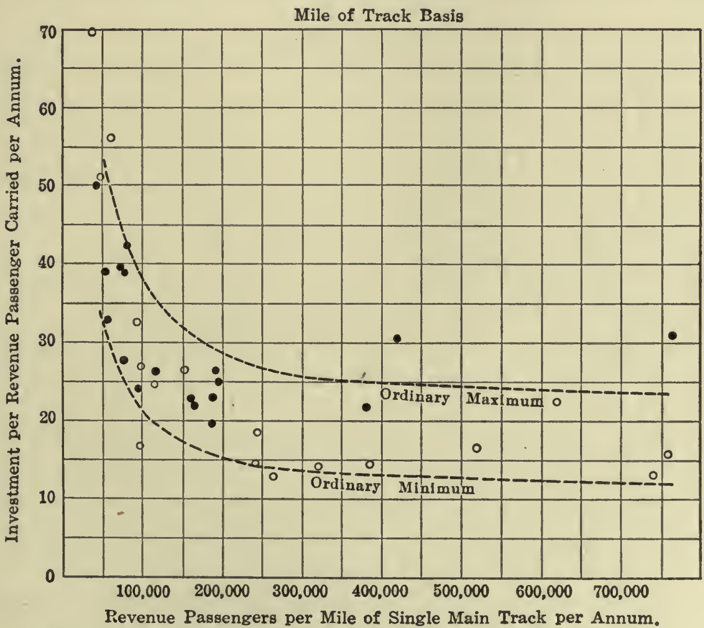

FIG. 13.—Relation between investment and density of traffic.

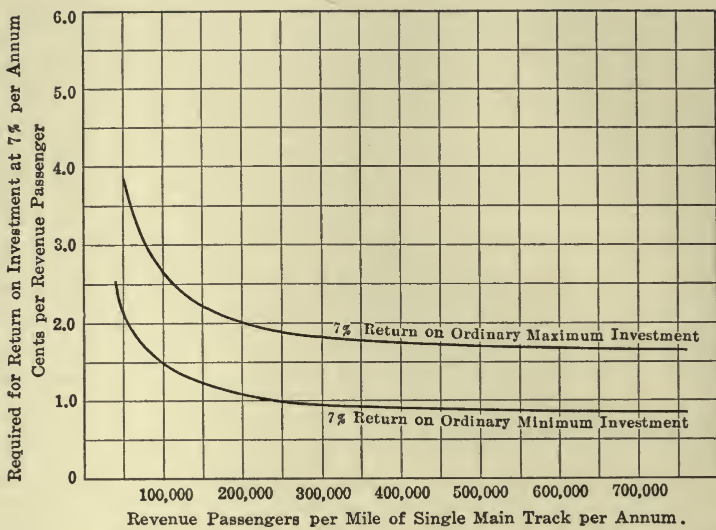

FIG. 14.—Relation between density of traffic and the amount required for return on investment per revenue passenger, assuming an average return of 7 per cent. on the range of investment shown in Fig. 11.

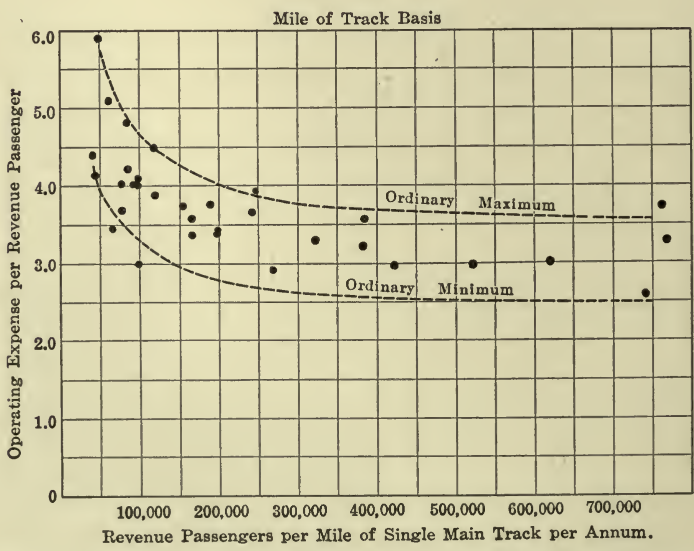

FIG. 15.—Relation of operating expenses per passenger to density of traffic.

tion of the corresponding curves on the plots based on the car-mile unit of density. The transfer is accomplished by the use of the average curve showing the approximate relation between the two units of density of traffic, Fig. 1. Inasmuch as the curves thus transferred seem to follow the average location of the data, and to enclose practically all of the points, this method of determining the "ordinary maximum" and "ordinary minimum"

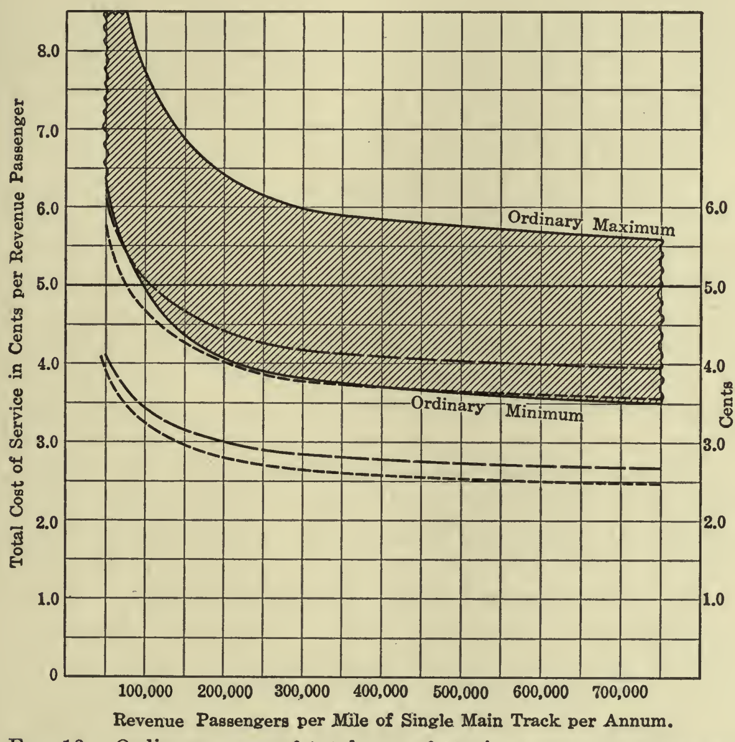

FIG. 16.—Ordinary range of total cost of service per revenue passenger. On basis of a 7 per cent. average return on ordinary range of investment. (This plot was developed in the same way as Fig. 9.)

curves for the supplementary plots seems justified. It is possible however, that additional data of investment and operating statistics might cause some modifications of all these various plots, but the general relations and approximate ranges shown seem to be reasonably well established by the data so far available.

Discussion of These Relations.—The broad general principle demonstrated by these statistics is that the average total cost of service per revenue passenger carried decreases as the density of traffic increases. This is clearly brought out in the case of the car-mile unit of density by Figs. 9, 10 and 11, and a supplementary demonstration is furnished by Fig. 16. While this general principle appears to be demonstrated for the average of a number of street railways, it is, of course, true that individual cases vary considerably.

Referring again to Fig. 9, it is seen that the portion of the shaded area (representing total cost of service per revenue passenger) which falls below the 5-ct. line is comparatively small. The "minimum" line on this plot shows that at least 5 revenue passengers per car-mile must be secured by a company having minimum investment, taxes and operating expenses, in order at a 5 ct. fare to just make receipts and outgo balance when paying a 7 per cent. return. On the other hand, even with expense conditions at the ordinary maximum, a company securing 7 revenue passengers per car-mile should be reasonably certain of earning about 7 per cent. It appears, however, that 7 revenue passengers per car-mile is an unusually high figure for street railways under present-day conditions, the average curve, Fig. 1, reaching only to 6½, although in a few companies the figures reach approximately 7 revenue passengers per car-mile.

Due to the fact that the average number of revenue passengers per car-mile does not increase to any extent with increase beyond 250,000 to 300,000 passengers carried annually per mile of single main track, there is naturally little or no decrease in the total cost of service curves, Fig. 16, beyond this density.

A study and comparison of Figs. 1, 9 and 16 must make it fairly clear that electric railway operation in a large city with an apparently heavy traffic does not necessarily mean large profits. On Fig. 16, the "ordinary maximum" cost curve is well above 5 cts. per revenue passenger, even at the high density of 700,000 revenue passengers per annum per mile of single main track. A company which, because of expensive construction, has a maximum of investment per revenue passenger carried per annum, and because of unfavorable operating conditions has maximum operating expenses per passenger, may be unprofitable even in a very large city. In many large cities, long hauls tend to reduce the number of passengers per car-mile below the normal level indicated by the average curve in Fig. 1, and thus tend to make the total cost of service per revenue passenger abnormally high.

Possibilities for Low Fares.—It is plain that low fares can be secured only where traffic density is high. Judging from the trend of the minimum curves, Fig. 9, 3-ct. fares do not come within the range of ordinary possibility until about 8 revenue passengers per car-mile are being secured, and then they are possible only when operating expenses and investment are practically at a minimum. In the case of Cleveland, Ohio, the total actual cost of service per revenue passenger in 1915 was about 3.46 cts.,[1] the density of traffic being 7.10 revenue passengers per car-mile, 730,000 passengers being carried per annum per mile of single main track, the average rate of return a trifle under 6 per cent. on the scaled down stock, operating expenses including depreciation or renewal charges amounting to 17.78 cts. per car-mile (a little more than "ordinary minimum" used in the present discussion), and the par value of the scaled down securities about 13½ cts. per revenue passenger (also a trifle more than the "ordinary minimum"). These figures fit in very well with Fig. 10.

With regard to the low fares on the British Municipal Tramways, it is demonstrated in Chapter IX that these low fares are coincident with short hauls and high traffic density, although the comparison of British and American fares is not complete until the lower wage scales and absence of free transfers abroad are considered.

The most obvious way to increase the number of revenue passengers per car-mile and thus secure lower unit fares is to decrease the length of ride allowed for the single fare and to charge an extra fare for longer hauls, thus in effect dividing the long ride into two or more short rides for which separate fares are paid. Increasing the capacity of cars may increase the number of passengers per car-mile, but it would ordinarily have little or no effect on the number carried per mile of track. Moreover, larger cars would probably mean somewhat increased operating expenses, and this with the added investment for the new cars would be an item to be balanced against the increased revenue per car-mile.

In subsequent chapters of this report, the relation of length of haul to density of traffic, the relation of rate of fare to density

[1] See Chapter VII, "A Study of the Three-cent Fare System in Cleveland."

of traffic, and proposed methods of revising fare systems in accordance with the findings and conclusions of this research, are discussed in detail. Reasonably frequent headway must be maintained to satisfy the public, and there is no advantage in operating larger cars where there is not sufficient traffic to keep their seats reasonably well filled.

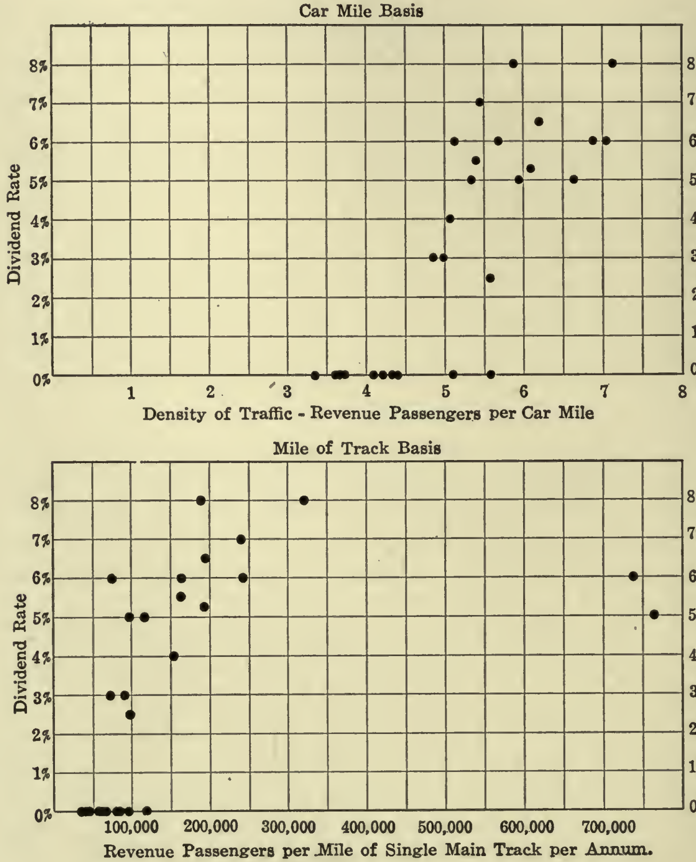

Fig. 17.—Relation of dividends to density of traffic.

What appears to be a supplementary confirmation of the foregoing statistical proofs that density of traffic is the most vital factor in the cost of service per revenue passenger, is shown in Fig. 17, in which the dividend rates of the majority of the 35 street railways considered are plotted against density of traffic. While no definite mathematical relation can be expected, it is evident that there is a general increase in the dividend rate as the density of traffic increases. The data available for plotting Fig. 17 are too few to make the demonstration conclusive in itself, so that it is offered here only as supplementary evidence in connection with the preceding discussion.

CHAPTER III

RELATION OF LENGTH OF HAUL TO DENSITY OF TRAFFIC AND COST OF SERVICE

The attempt to apportion street railway operating expenses and fixed charges directly to the length of ride of any individual passenger or group of passengers presents a very difficult problem. A 2-mile ride on one portion of a line may have a very different cost from an equal length of ride on another portion of the same line, due to differences in cost of construction, to denser or thinner traffic, to differences in speed of operation and to other causes. Again, a 2-mile ride at one time of day may be responsible for a very different cost from that of the same ride at another time of day, because of peak-load conditions. Even were it possible, as a practical matter to compute accurately the cost of each individual ride of varying lengths on different parts of a line and at different times of day, it would be of little or no value because fares could not and should not be charged on such a basis.

Fares can be based only on general averages approximating average costs of service.

Effect of Longer Hauls on Cost of Service.—It is, however, an essential factor in this work to determine whether or not, as a general average proposition, long hauls on street railway lines are more costly to furnish than short ones. This is a proposition, the answer to which would seem to be an almost self-evident affirmative, yet it has been disputed frequently and vigorously in the past, sometimes by exponents of public opposition to fare increases and also by not a few street railway men.

The street railway man is apt to look at this problem with the view that the car has to make a certain length of trip anyhow, and that consequently it does not make any particular difference if the passengers who board it ride only a part or the whole of the car trip. This opinion, however, takes in but a narrow view of the situation. It overlooks the basic fact that if some of the passengers did not have to be furnished with this long ride to the extreme end of the line, the cars would not have to run so far, and thus fewer car-miles would be required to be run, with a coincident saving in operating expenses; and the last portion of the line might not have to be constructed at all, which would mean a saving in investment. As the number of passengers who do ride to the very end of such lines is generally small in proportion to the traffic on the remainder of the line, it follows that even if they were lost entirely as patrons of the street railway, their loss might be, in fact, a gain. It is probable in such a case that many of these would walk to or from the terminus of the line, if it did not extend quite out to the place where they live.

The point is that the shorter the line, the less should be the cost of service per passenger. There is a practical limit to this proposition, in that a very short line, say one of much less than 2 miles, would be of so little use to the public that it would not ordinarily attract much traffic. Along such a short line, the major part of the population would be able to serve itself by walking.

How the Short Ride is Made Profitable in City Service.— All progressive and economical street railway managers in large cities where single-fare lines are long, have adopted the "tripper" system of operating cars to reduce the car mileage and consequently the expenses. The "tripper" system consists in turning back part of the cars on any given line at some point only part way out toward the end of the route.

For instance, let the line *ABC*, Fig. 18, represent a 6-mile route extending from the center of the city, *A*, into the outlying suburb, *C*. The total traffic would ordinarily be heavy near the city end of the line, growing lighter toward the suburban end, somewhat as shown in Fig. 18 where the ordinates indicate passengers carried. In such a case, if all cars made the whole length of the route on each trip, they would be very lightly loaded on the outer half of the route as compared with their loading on the inner half. Efficient operation entails a splitting of the service, whereby a short headway, say 5 min. between cars, is maintained on the inner half, and a longer headway, say 10 min. between cars, is maintained on the outer end. This is accomplished by turning every second car back at point *B*, while alternate cars run through to *C*. Thus fewer cars are needed to operate the line and give adequate service, than if all ran to *C*, and there is, moreover, a saving in operating expenses, approximately in proportion to the saving in car mileage.

Since the car making the half trip, *A* to *B*, can presumably accommodate the same number of passengers on leaving *A* as the long-trip car, and since its operating expense for the short trip is certainly less, the cost of service per passenger is less, and consequently the profit per passenger is greater for the short ride where the fare is at a flat rate per ride.

Density of Traffic Limited by Capacity of Car and Length of Trip.—On the ordinary present-day street railway, the modern type of street car seats from 45 to 55 passengers. A standing load of about 50 per cent. of the seating capacity can be carried without undue crowding or discomfort. In rush hours practically every car has more or less standing passengers in the direction of traffic flow, but the cars return nearly, if not wholly,

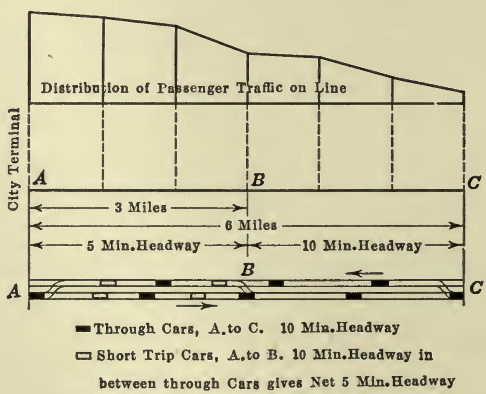

Fig. 18.—Illustration of tripper service.

empty. In the non-rush hours, there are usually some vacant seats in both directions, the proportion depending upon the closeness with which the transportation officials regulate the car service to the average traffic.

In ordinary American city service a very large proportion, if not all of the traffic, flows to and from a central business district.[1] On the outbound trip practically all of the passengers carried, enter the car in or near the center of the city and ride radially outward to various points along the lines. On the inbound trip,

[1] This fact is really a matter of common observation. It was well substantiated by the information obtained from passengers on six different radial lines of the Boston Elevated Railway during a traffic count, by senior students of the Massachusetts Institute of Technology, which was made as a thesis during the spring of 1915.

the reverse conditions obtain. The central district need not be considered as a geometrical point, or the loop where the cars are started back on the outbound trip. It may be a territory of a mile or more in radius. As a consequence of this concentration of traffic, the number of revenue passengers per trip, and consequently the receipts per trip at a single, flat rate of fare, are pretty well limited by the capacity of the car to hold passengers. Of course by overcrowding, the car may be forced to hold more passengers per car-mile, but common observation shows that in cities where overcrowding is found, it just as frequently occurs on the short-trip cars as on the long-trip cars. In the illustration of tripper service given above in connection with Fig. 18, the cars

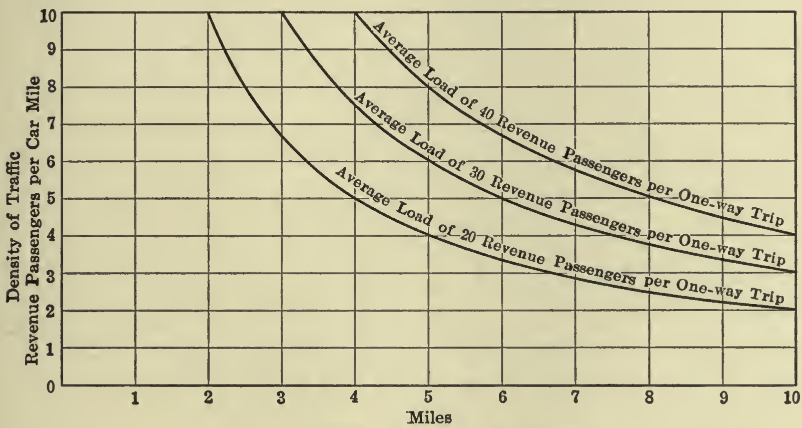

FIG. 19.—Relation of density of traffic to length of car trip (calculated). For ordinary average loads of 20 to 40 revenue passengers per trip.

running only to point *B* (half way out), would carry on the average nearly as many passengers per trip as those going all the way to *C*.

Because of the few passengers carried in the direction opposite to rush-hour travel, and the light loads in the evening and other non-rush hours, the average load per car per one-way trip, regardless of the length of trip, is apt to be from 20 to 40 revenue passengers, depending on the size of cars, characteristics of the line, frequency of service, etc. Then the longer the trip, the smaller will be the average number of revenue passengers per car-mile, with any given average load per trip. In Fig. 19 the decreasing number of passengers per car-mile, with increasing length of trip, is shown for several assumed conditions of average load between 20 and 40.

It is a difficult task to get really comparable statistics from operating street railways as to the effect of longer hauls on density of traffic. If the numbers of passengers per car-mile on lines of different lengths even in the same city are taken, the meaning of the results is often quite obscure. This arises from the number of varying factors which affect density of traffic. Different qualities of service, different capacity cars, varying rush-hour characteristics, diverse character of population and territory served all enter in to make the density of traffic analyses more or less incomparable.

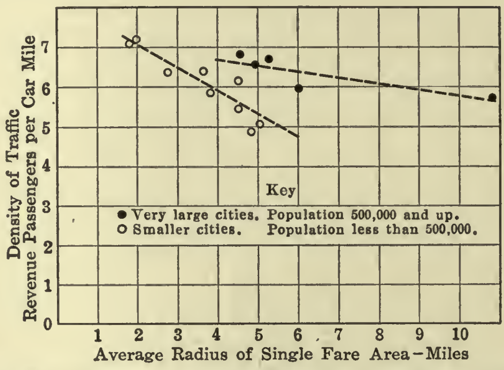

FIG. 20.—Relation of length of haul to density of traffic.

Such data as are available as to the relation of density of traffic to the radius of the single-fare area in fourteen cities which are perhaps fairly comparable, however, seem to agree with the *a priori* considerations and indicate that the number of revenue passengers per car-mile decreases as the radius of single-fare operation increases. These results are shown in Fig. 20. Even here the decrease is not very clearly indicated until a rough separation of the data is made. The solid black dots represent five large cities in which cars of large capacity are operated, with more or less overcrowding in rush hours. The remaining points represent the data in eight smaller cities where smaller cars are run with less congestion of passengers. The terms "large" and "small" as here applied to the cities are used with reference to the total population, and are not necessarily related to the extent of the single-fare area. If the reasonableness of this separation be admitted, then it seems fairly well established by the operating data, at least as far as these fourteen individual cases go, that the longer the haul the smaller is the average number of revenue passengers per car-mile.

The effect of lower densities of traffic per car-mile, on the total cost of service per revenue passenger was clearly demonstrated in Chapter II (see Fig. 9). Since long hauls evidently tend to reduce the number of passengers per car-mile, and reducing the number of passengers per car-mile tends to increase the average cost of service per passenger, it follows that the long-haul passenger is more costly than the short-haul one.

Average Ride Longer on Longer Lines.—Not only is the density of traffic decreased by the operation of long lines for the benefit of more or less minor proportions of the passengers, but the average ride per passenger is longer on these long lines. It has been contended that the average ride is kept low on the long lines by the offsetting of long rides by an increased number of short rides. That such an assertion is unfounded seems clearly demonstrated by numerous data on length of haul which have been collected during the course of this research. These data, graphically represented in Fig. 21, show a well-defined increasing average length of ride with increasing length of line. The statistics for this plot were in the majority of cases secured from published reports as acknowledged on the figure. A few were furnished directly by street railway companies with the requirement that the companies' names be considered as confidential. All apply to lines in or about large cities in this country. In every case, traffic surveys were made in order to obtain the necessary data for computing the average ride. It is evident from this plot that the average length of ride increases with the length of line. The average length of ride appears to be about 50 per cent. of the length of line for short lines, with a decreasing percentage for lines above 4 miles in length.

The next four plots, Figs. 22 to 25, show the data for four of the individual cities, Philadelphia, Providence, San Francisco and Boston respectively, which were included in the general plot, Fig. 21. The traffic counts made to determine the average length of ride on six Boston lines, Fig. 25, were performed in the summer of 1914 by members of the Research Division staff. Even including only six of the many lines in Boston, the general

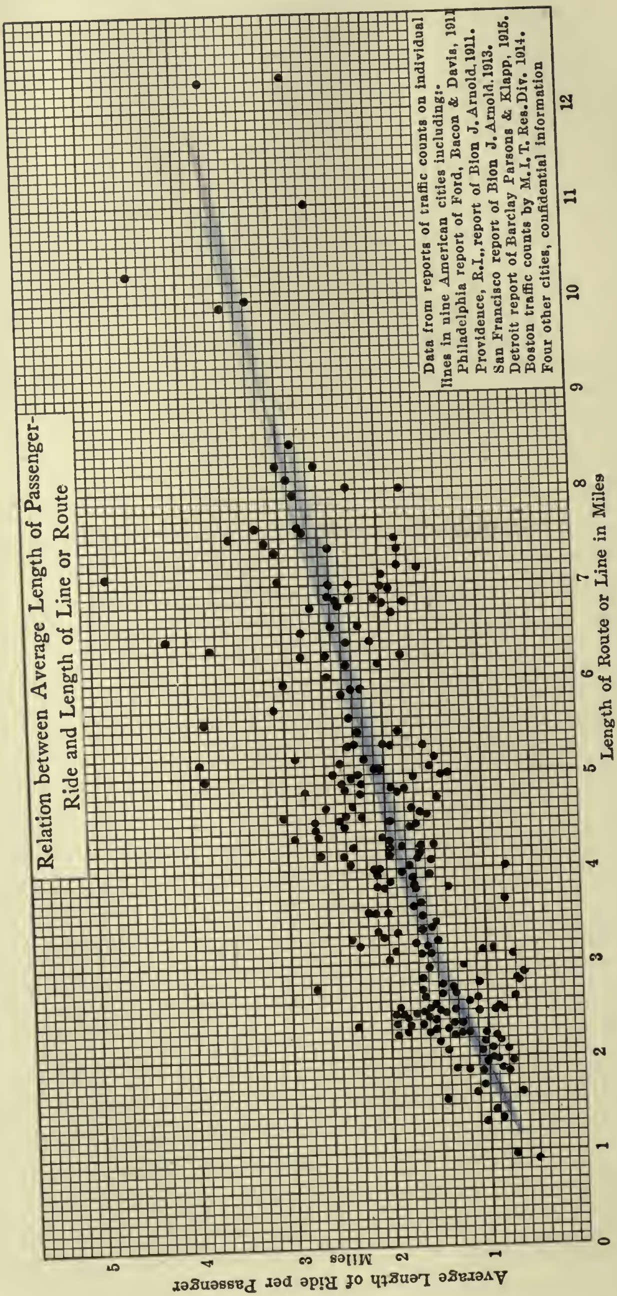
Relation between Average Length of Passenger-Ride and Length of Line or Route
Data from reports of traffic counts on individual lines in nine American cities including:-
Philadelphia report of Ford, Bacon & Davis, 1911
Providence, R.I., report of Bion J. Arnold, 1911.
San Francisco report of Bion J. Arnold, 1913.
Detroit report of Barclay Parsons & Klapp, 1915.
Boston traffic counts by M.I.T. Res. Div. 1914.
Four other cities, confidential information
Length of Route or Line in Miles
Average Length of Ride per Passenger
Miles
0
1
2
3
4
5
6
7
8
9
10
11
12

FIG. 21.

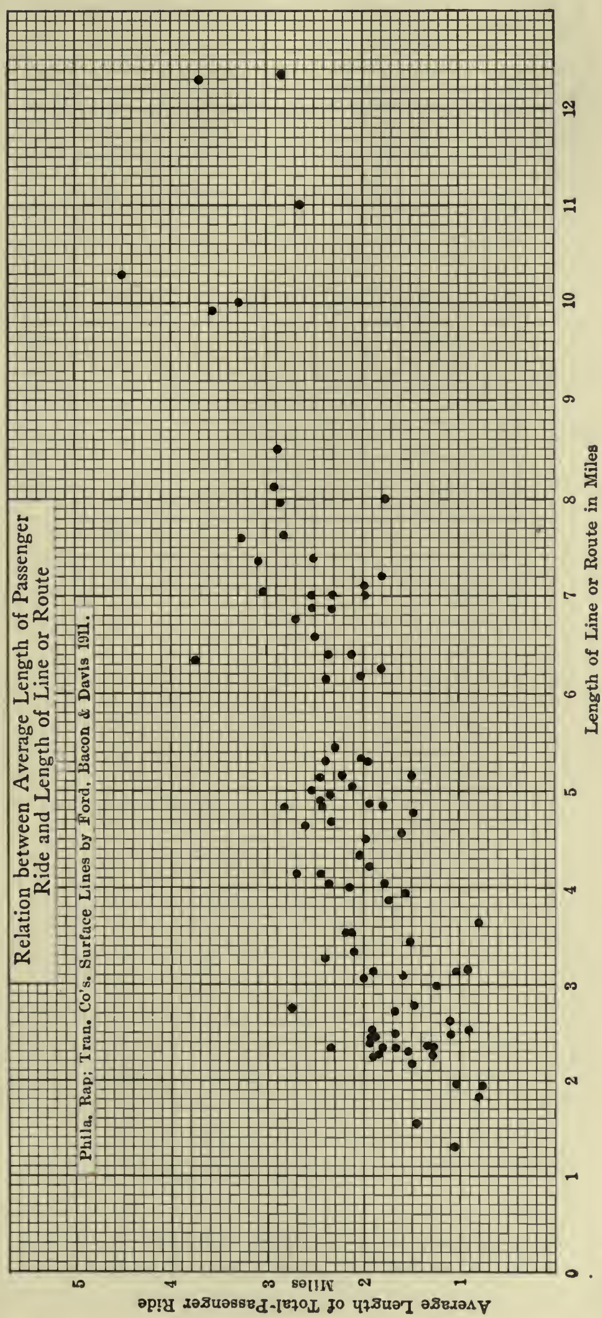
Relation between Average Length of Passenger Ride and Length of Line or Route
Phila. Rap; Tran. Co's. Surface Lines by Ford, Bacon & Davis 1911.
Average Length of Total-Passenger Ride
Miles
0 1 2 3 4 5
0 1 2 3 4 5 6 7 8 9 10 11 12
Length of Line or Route in Miles

FIG. 22.

rule of increasing average length of ride on longer lines is shown.

FIG. 23.—Relation between average length of passenger ride and length of line or route.

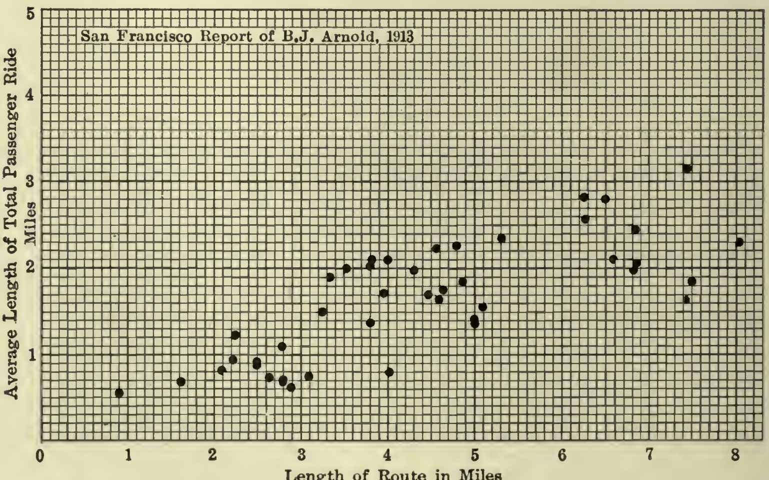

FIG. 24.—Relation between average length of passenger ride and length of line or route.

Different cities are likely to show more or less distinct characteristics in the relation of average length of haul to length of line, due to particular local topographical features, to the distribution of business centers and residential districts and to other local conditions. The individual peculiarity of the Providence lines (Fig. 23) is especially striking. It happens that the business district in Providence is rather limited in radius, and some of the thickly settled residential districts closely encircle the business area. Consequently a great many people live within walking distance of their places of occupation. This residential belt is a comparatively narrow one, and just beyond it there is much open and very thinly settled territory. The cars, after a short run from the center of the city, strike open territory where few passengers board or leave. Farther out from

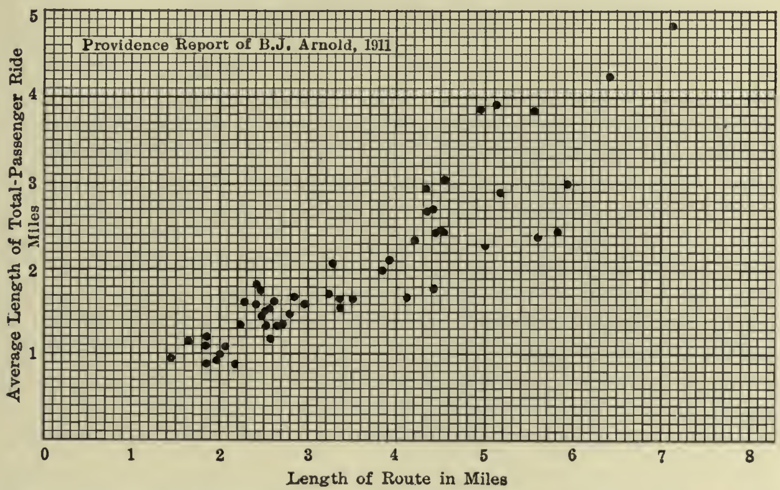

FIG. 25.—Relation between average length of passenger ride and length of line or route.

Providence there are a number of smaller cities, towns and hamlets to which through cars are run. Pawtucket is the largest neighboring city. As a consequence of this distribution of population, much of the traffic on the Providence lines is made up of long riders, *i.e.*, those who ride "through" from the center of Providence to the outlying centers, and, therefore, the average ride per passenger is longer in proportion to the length of line than in the ordinary city where the population is more evenly distributed.

When the data from these several cities are segregated into two groups, one group including the lines of a cross-town nature, and the other one all lines of the radial type, it is found that

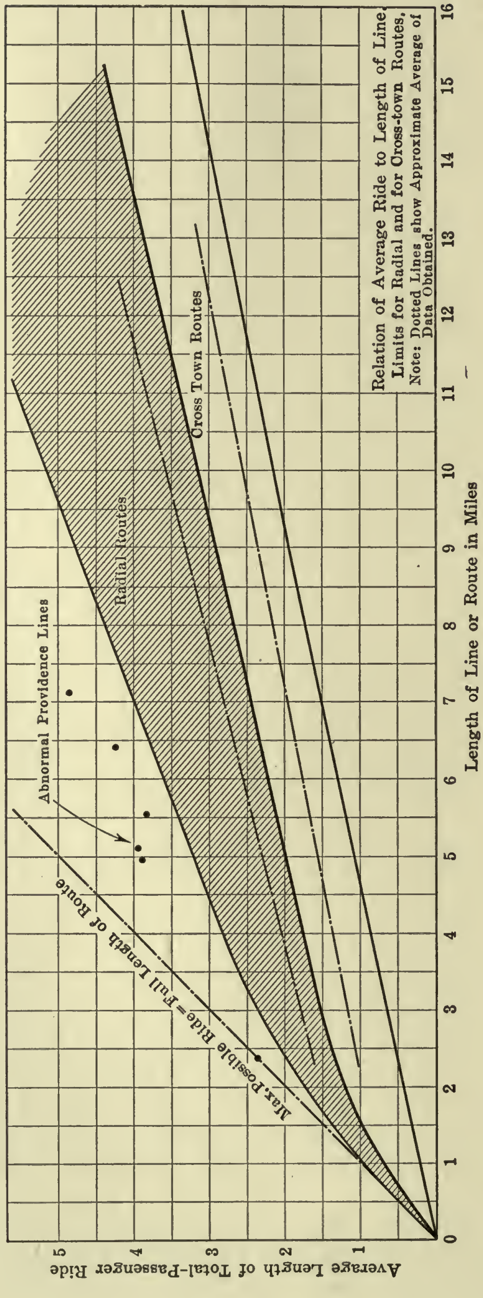
Relation of Average Ride to Length of Line.
Limits for Radial and for Cross-town Routes.
Note: Dotted Lines show Approximate Average of Data Obtained.
Cross Town Routes
Radial Routes
Abnormal Providence Lines
Max. Possible Ride = Full Length of Route
Average Length of Total-Passenger Ride
Length of Line or Route in Miles
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16

FIG. 26.

the average length of passenger ride increases more rapidly with increasing length of line on the radial than on the cross-town routes. In Fig. 26 is shown the approximate range covered by these data, when separated between radial and cross-town lines. The line on the plot representing the division between the two groups is a more or less arbitrary one. About 15 per cent. of the radial line data fell in the cross-town group below this line, and conversely about 15 per cent. of the cross-town data fell in the radial group. Although a cross-town line may be of considerable length, it is apt to get a greater proportion of short riders than a radial line, because a greater proportion of its length is apt to be within the limits of the congested business district.

Average Length of Haul—Proportions of Long and Short Rides.—As a result of some quite thorough traffic counts, there are a few general figures available as to the average length of ride, within the single-fare limits in two large cities, viz.:

Philadelphia, in 1911: Average length of ride, 2.79 miles.[1]

Milwaukee, in 1911: Average length of ride, 2.74 miles.[2]

As no data were available to show the numbers or proportions of passengers taking long rides, short rides and rides of intermediate lengths, a special traffic count was inaugurated by the Research Division on certain lines of the Boston Elevated Railway Company in the spring of 1915. The work of securing the data and compiling the results was carried on as a thesis by students in the Electrical Engineering Department of the Massachusetts Institute of Technology, under the direct supervision of the Research Division. The methods followed and details of the work have been described at length in a published report,[3] so that only a brief summary need be given here.

Observers boarded a certain proportion of all the cars on the selected routes, and by noting the street where each passenger

[1] The Philadelphia figures were published in the 1911 Report to the Pennsylvania Railroad Commission by Ford, Bacon and Davis, vol. i, p. 87. This figure is the average ride per revenue passenger for the whole Philadelphia Rapid Transit System, within the 5-ct. fare limit. It includes the subway-elevated as well as the surface system.

[2] The Milwaukee figure was published in the report of the Milwaukee Fare Case, in the Opinions and Decisions of the Wisconsin Railroad Commission, 10 W. R. C. R., p. 291.

[3] "Determining the Actual Length of Ride," by D. J. McGrath, *Electric Railway Journal*, March 25, 1916, p. 595.

boarded the car, and by asking the necessary questions as to final destination and proposed route, the limits of the trip of each passenger could be determined. Small individual cards were

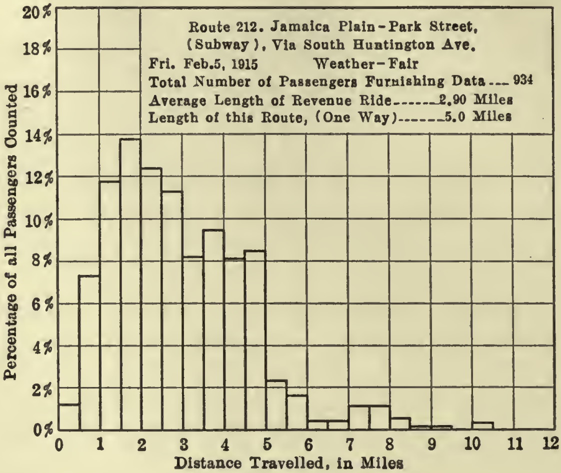

FIG. 27.

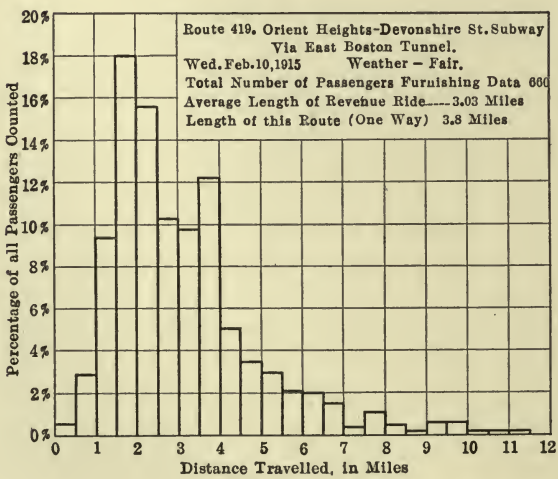

FIG. 28.

used for recording the data for each passenger. At the conclusion of the count, one whole day being allotted to observations on each of six different lines, the data were compiled by measuring, on especially prepared charts of the various routes, the distance in miles which each passenger would cover in making the trip designated. The distances were then sorted out by groups of each ½ mile, and the percentage of passengers riding ½ mile

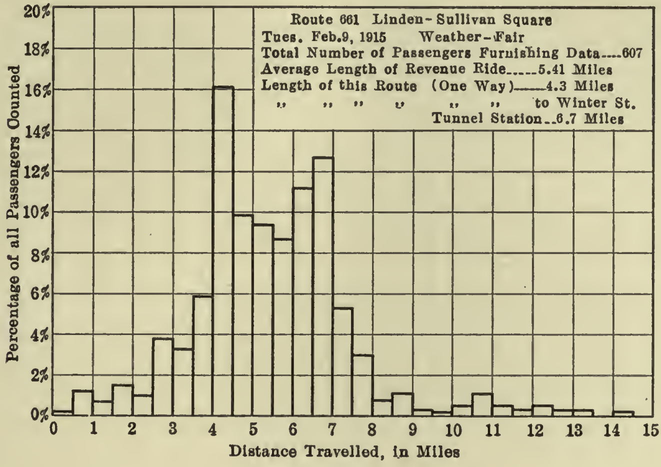

FIG. 29.

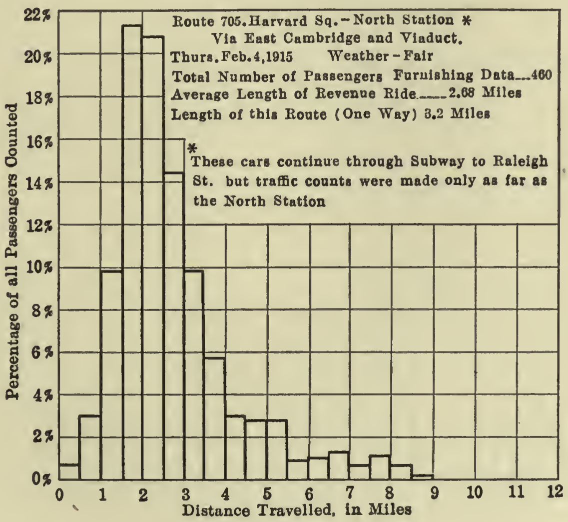

FIG. 30.

or less, ½ to 1 mile, 1 to 1½ mile, etc., were computed. Some passengers travelled more miles than the length of route concerned, which is accomplished by utilizing transfer privileges.

These results are shown graphically in Figs. 27 to 33, the last one being a check count, on the same route as Fig. 32. This check count was made in the same way, on a different day of the

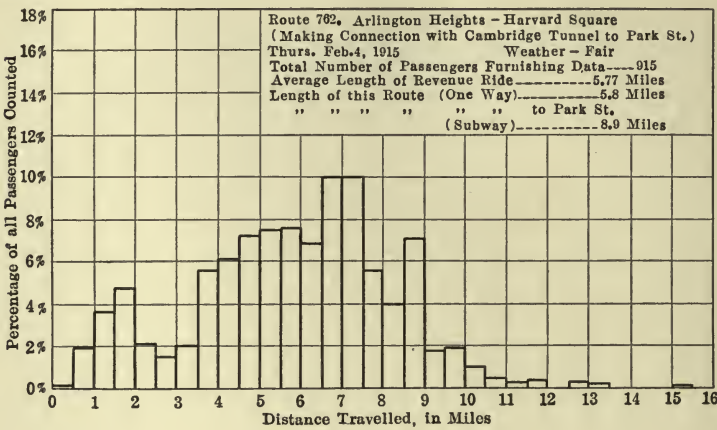

FIG. 31.

week, and a different running schedule for the observers, to determine whether or not the results from the rather limited amount

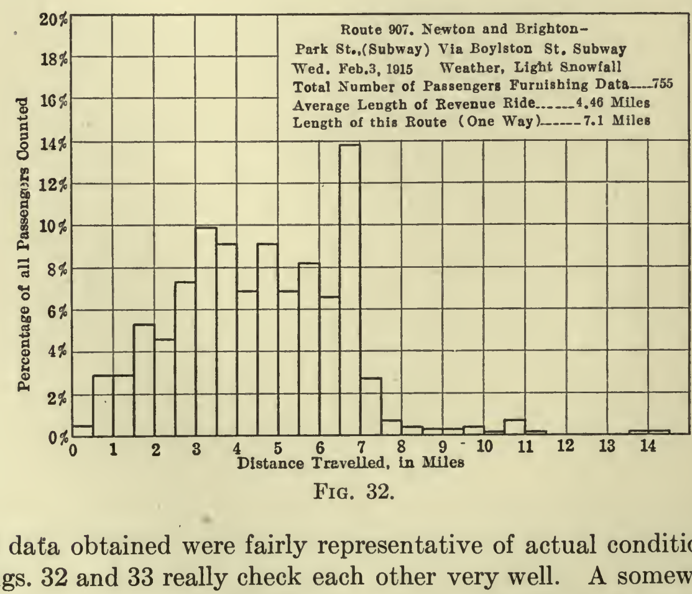

FIG. 32.

of data obtained were fairly representative of actual conditions. Figs. 32 and 33 really check each other very well. A somewhat similar count was made on another day by questioning a number of passengers entering the central, in-town, tunnel stations as to their ultimate destinations on the lines of the Boston Elevated Railway. These results are shown in Figs. 34 and 35, which give a quite definite idea of the distribution of passenger traffic from the center of the city to the outlying suburbs.

From the results of this novel traffic survey, as indicated in the above-mentioned Figs. 27 to 35, it is clear that there are a number of very short rides, and also a number of very long rides taken by various passengers on the transportation system of a large city, all such rides being at the uniform rate of fare of 5 cts.; and the average ride per revenue passenger, on these six lines, is seen to vary from about 2.7 miles on a fairly short line,

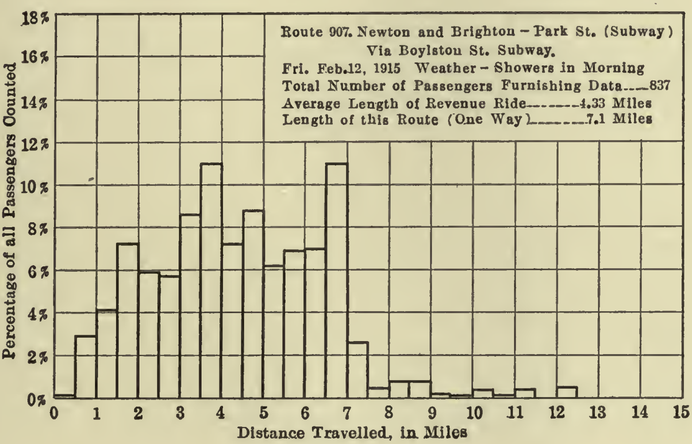

FIG. 33.

to 5.8 miles on a very long line. The number of lines on which observations were made was not sufficient to permit of any final conclusion as to the average ride per passenger on the whole system.

It was also demonstrated that the average ride of a passenger using a transfer was longer than that of the average non-transfer passengers, and that the average ride increased still further as the number of transfers used per revenue passenger increased. Universal free transfers are issued in Boston between most lines, including surface to rapid transit and *vice versa*, so that for one 5-ct. fare it is possible for a passenger to make two or three free transfers in Boston. Table I gives a summary of the average

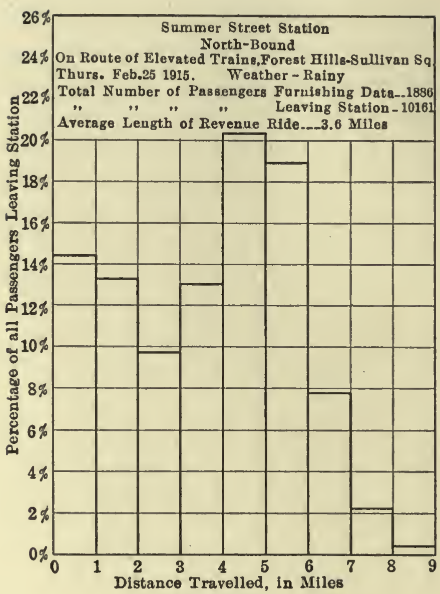
Summer Street Station
North-Bound
On Route of Elevated Trains, Forest Hills-Sullivan Sq.
Thurs. Feb. 25 1915. Weather - Rainy
Total Number of Passengers Furnishing Data...1886
" " " " Leaving Station - 10161
Average Length of Revenue Ride....3.6 Miles
Percentage of all Passengers Leaving Station
26% 24% 22% 20% 18% 16% 14% 12% 10% 8% 6% 4% 2% 0%
0 1 2 3 4 5 6 7 8 9
Distance Travelled, in Miles

FIG. 34.

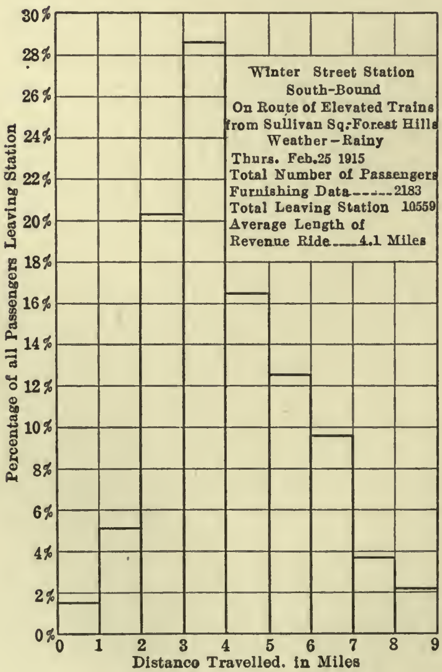
Winter Street Station
South-Bound
On Route of Elevated Trains from Sullivan Sq.-Forest Hills
Weather - Rainy
Thurs. Feb. 25 1915
Total Number of Passengers Furnishing Data.......2183
Total Leaving Station 10559
Average Length of Revenue Ride......4.1 Miles
Percentage of all Passengers Leaving Station
30% 28% 26% 24% 22% 20% 18% 16% 14% 12% 10% 8% 6% 4% 2% 0%
0 1 2 3 4 5 6 7 8 9
Distance Travelled. in Miles

FIG. 35.

lengths of ride, according to number of free transfers per ride on the several routes.

Extent of Single-fare Areas of Cities.—In connection with such studies as the ones discussed in this report, it is an essential feature to secure some data, for comparative purposes, on the extent of the areas served by city street railway systems for the single fare. Accordingly a set of maps was prepared to a uniform scale showing the extent of the single-fare lines. These maps are grouped in Figs. 36 and 37.[1] They were prepared from information secured from various sources, usually from maps of the lines furnished by the street railway companies upon special request. Special acknowledgment is made where the data were derived from published reports. In a number of cases the actual location of the single-fare limits has been checked by the personal knowledge or observation of some members of the Research Division, but, of course, this was possible in only a limited number of instances.

Table I.—Summary of Passenger Mileage for Surface Lines According to Number of Transfers

Originating Route	Passengers using no transfers Av. Ride Miles	Passengers using 1 transfer Av. Ride Miles	Passengers using 2 transfers Av. Ride Miles	Passengers using 3 transfers Av. Ride Miles	Average Ride Miles.
212	2.45	3.04	4.98	6.77	2.90
419	2.19	3.35	6.36	7.60	3.03
661	4.95	5.55	7.32	9.37	5.41
705	2.11	3.79	5.80	....	2.68
762	5.20	6.67	9.03	10.30	5.77
907	4.21	4.34	5.81	10.03	4.46
907*	3.92	4.46	5.57	10.15	4.33

* Check count.

It will be observed that some systems have spread out so as to include a very large radius of operation at a 5-ct. fare. For instance, the Chicago surface lines operate to and from the boundary nearly 16 miles south of the central business district, only one 5-ct. fare being collected from passengers making this very long trip, and indeed it is possible for such a passenger to obtain a free transfer and ride on to about 10 miles north of the center. Other smaller cities have maintained a much more limited

[1] Reprinted from "Long Rides for a Nickel," by D. J. McGrath, *Electric Railway Journal*, Aug. 5, 1916.

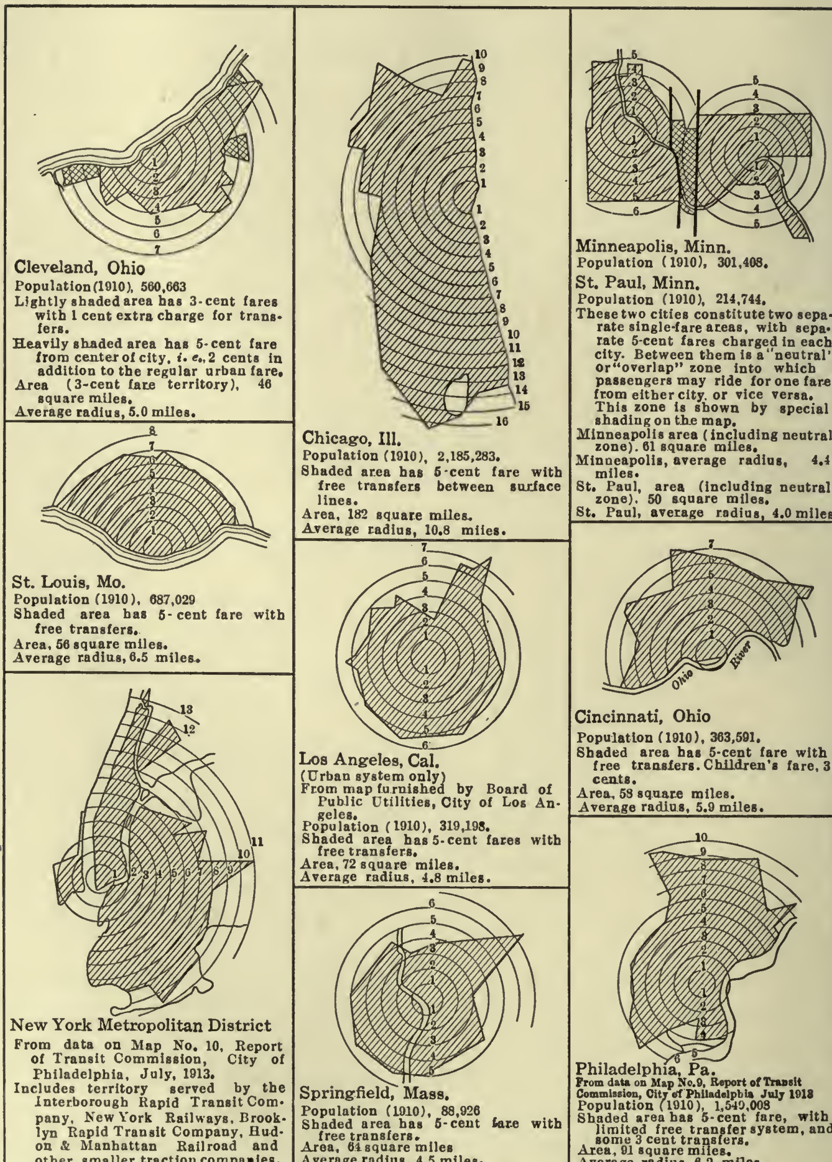

FIG. 36.—Maps of single-fare zones in typical cities. Figures indicate radii of circles in miles from traffic centers.

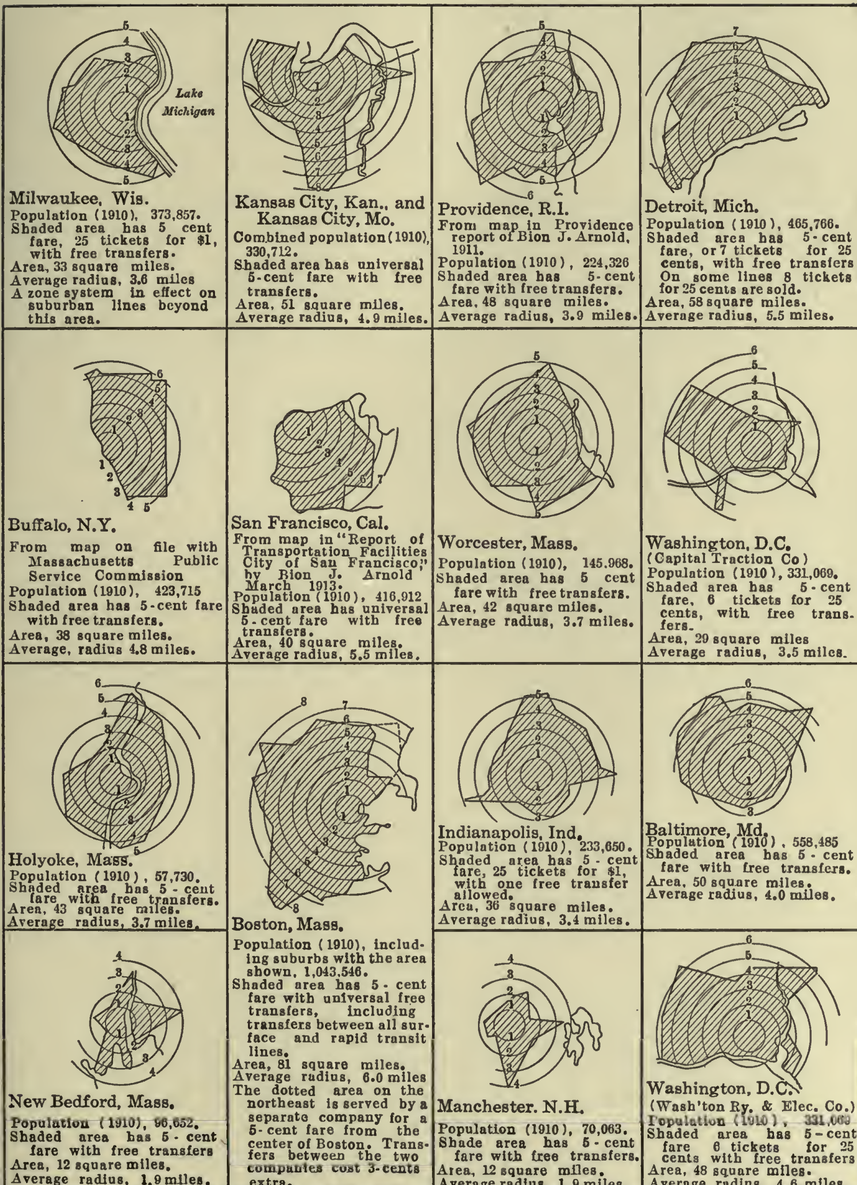

Fig. 37.—Maps of single-fare zones in typical cities. Figures indicate radii of circles in miles from traffic centers.

radius. Such for instance is the case in Manchester, N. H., New Bedford, Mass., and others.

In the majority of cities, it is clearly shown that there are a number of fairly long lines within the single-fare area.

Conclusions.—The general conclusions upon the subject of length of haul may be summarized as follows: Longer average hauls occur on the long lines than on the short ones; the number of passengers per car-mile is reduced under long-haul conditions, and consequently the average cost of service per passenger is increased as shown in Chapter II. The lower density of traffic and consequent higher average cost per passenger is due to the necessity of extending tracks and running cars to greater distances for the accommodation of a proportionately small number of long riders, so that at a flat rate of fare the long-haul passenger is paying less in proportion to the cost of his ride than the short-haul passenger.

CHAPTER IV

RELATION OF RATE OF FARE TO GROWTH OF TRAFFIC

Normal Growth of Traffic.—Street railways have generally shown in the past a fairly steady annual increase in the number of revenue passengers carried. This comes about partially because of increases in population, and also because in many cities there has been found to be an increase in the "riding habit" of the population as the population grows, up to certain limits. The growth of traffic has also been observed to depend to some extent upon business conditions. In prosperous times, the growth of traffic is stimulated; in times of business depression, it is retarded. A new factor has been introduced recently, in the form of competition by motor vehicles. Much traffic has been diverted from the street railways by the automobile. In many cities the mushroom growth of jitney service has cut into street railway traffic, temporarily at least, to a very material extent. In suburban and rural districts, the privately owned motor car is the more serious form of competition; and in some cities motor-busses are becoming a competitive factor.

There is another factor, however, which has been found to have a very direct bearing upon the growth or decrease of traffic. Changes in the rate of fare have shown a clearly defined change in the rate of traffic growth in practically every case for which we have found any data available.

Effect of 6-ct. Fares on Traffic on Massachusetts Roads.—During the past 8 years, several Massachusetts street railways of the suburban and interurban type have increased their fares from 5 to 6 cts., maintaining the same irregular zones and fare limits. These increases in rates were sanctioned by the Massachusetts Railroad Commission (more recently reorganized as the Massachusetts Public Service Commission) only after considerable investigation had established the conclusion that the companies concerned were not earning a fair return at 5-ct. fares. The statistics of these several companies, shown graphically in the charts, Figs. 38 to 46, indicate a loss in traffic accompanying the increase in fares in practically every case. In some cases

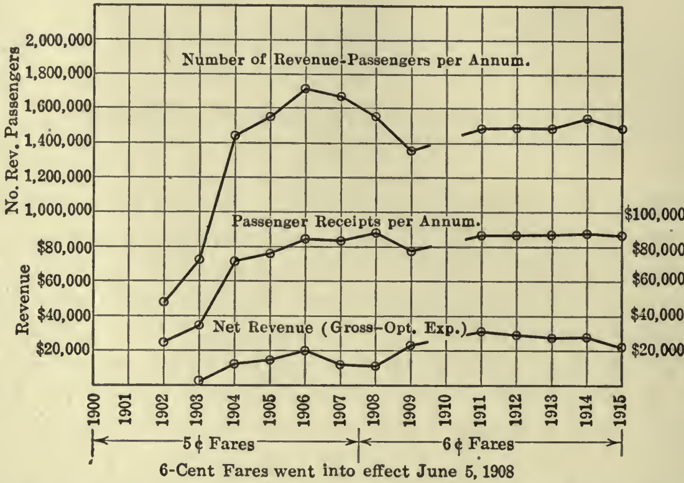

FIG. 38.—Effect of 6-cent fares on the Blue Hill Street Railway. Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

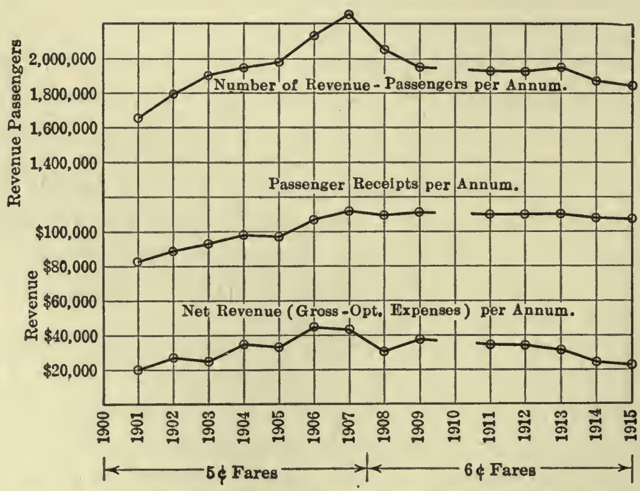

FIG. 39.—Effect of 6-cent fares on the Brockton and Plymouth Street Railway. Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

the loss was very considerable, and was not recovered for many years, if at all. In other cases the traffic loss was less severe, but nevertheless plainly marked. In two cases, the loss was simply an accelerated continuation of prior losses. Due to these traffic losses the companies received little or no increases in gross reve-

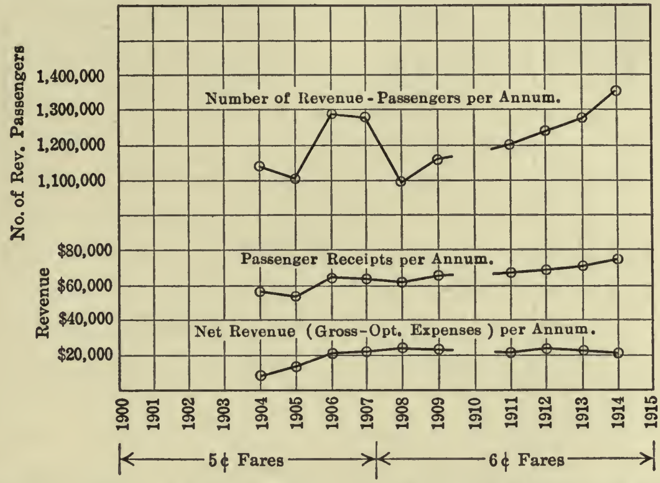

FIG. 40.—Effect of 6-cent. fares on the Concord, Maynard & Hudson Street Railway. (Includes Lowell, Acton & Maynard, 1904–1912.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

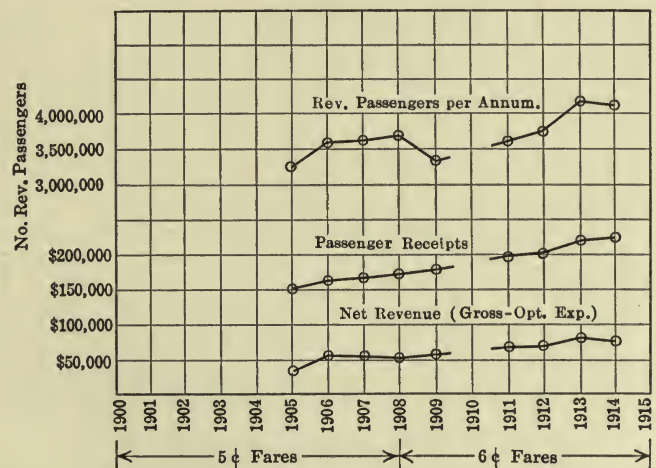

FIG. 41.—Effect of 6-cent fares on the Connecticut Valley Street Railway. Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

nue, in spite of a 20 per cent. increase in rates of fare. Where expenses can be decreased by a material curtailment of car service, an increase in net revenue may be gained, but patrons of the average street railway will scarcely be in the frame of

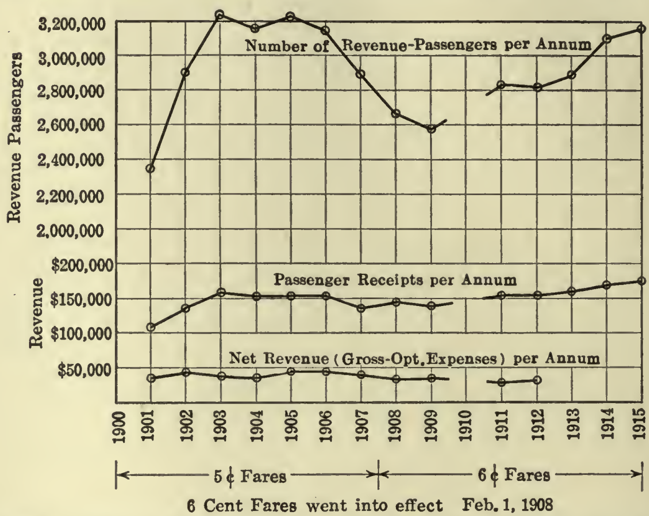

Fig. 42.—Effect of 6-cent fares on the Lexington and Boston Street Railway. (Part of Middlesex & Boston St. Ry. since 1912.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

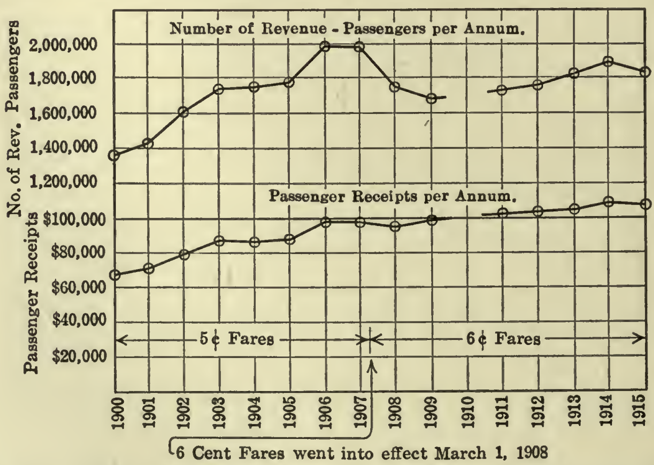

Fig. 43.—Effect of 6-cent fares on the Natick and Cochituate Street Railway. (Part of Middlesex & Boston St. Ry. since 1908.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

mind to peaceably accept a reduced or poorer grade of service, simultaneously with a 20 per cent. increase in fares. This is one of the very important psychological aspects of the fare problem

It is not intended to assert that these companies committed a financial blunder by increasing fares, but the results for the

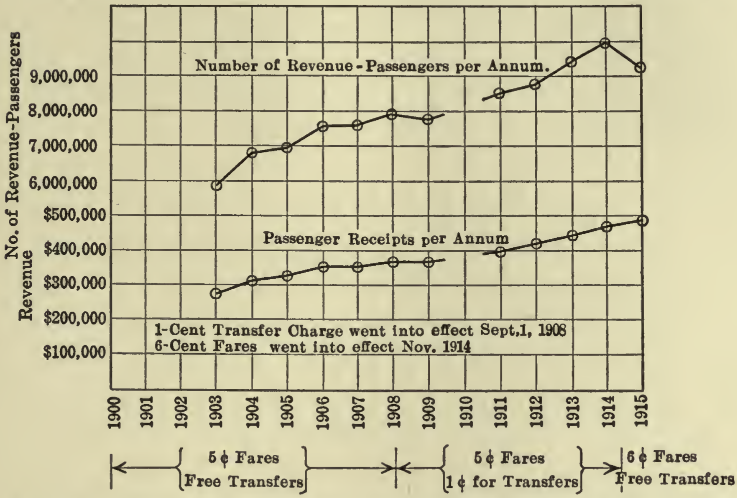

FIG. 44.—Effect of 1-cent transfer charge and 6-cent fares on the Newton Street Railway. (Part of Middlesex & Boston St. Ry. since 1909.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

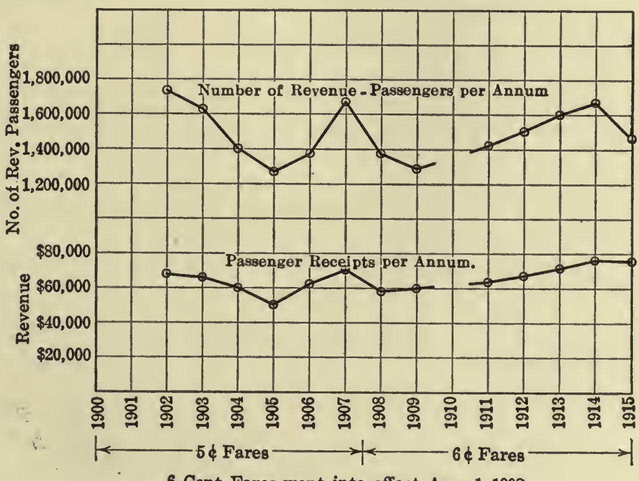

FIG. 45.—Effect of 6-cent fares on the Newton and Boston Street Railway. (Part of Middlesex & Boston St. Ry. since 1909.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

majority were not particularly encouraging. It is evident that 6-ct. fares caused a great many people to cease using the cars, and it is fair to assume that a portion and probably a fairly large portion of them were short riders who preferred to put themselves to the discomfort of walking rather than to pay the higher fare for a trip of 1 or 2 miles. The question arises whether shortening the zones with 5-ct. or lower unit fares, or possibly even a mileage rate, would not give more satisfactory results to both the riding public and the carrying company.

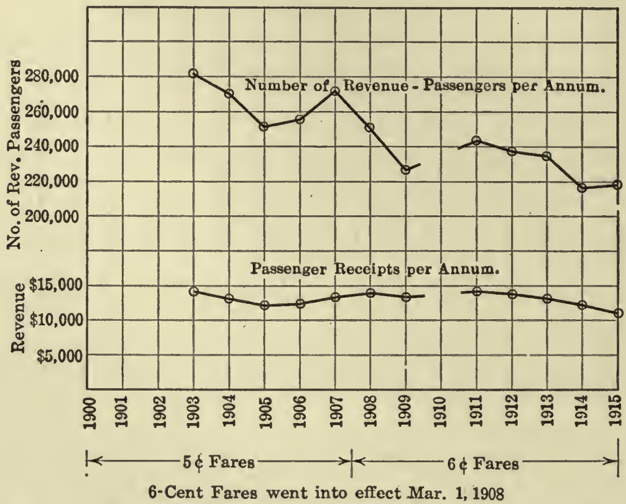

FIG. 46.—Effect of 6-cent fares on the Westboro and Hopkinton Street Railway. (Part of Middlesex & Boston St. Ry. since 1909.) Fiscal years shown above end Sept. 30 until 1909, and end June 30 thereafter.

Seven-cent Fares on the Hudson and Manhattan Tunnels.—In December, 1911, the fares in the so-called "uptown tubes" of the Hudson & Manhattan R. R. in New York City were increased from 5 to 7 cts. Statistics published by the New York Public Service Commission, First District, indicated an immediate loss in traffic, as follows:[1]

1910, uptown traffic at 5-ct. fares, 12,799,000 revenue passengers.
1911, uptown traffic at 5-ct. fares, 15,723,000 revenue passengers.
1912, uptown traffic at 7-ct. fares, 12,956,000 revenue passengers.
1913, uptown traffic at 7-ct. fares, 12,295,000 revenue passengers.

In this case the conditions and results were somewhat different from those on the street railways in Massachusetts. The Hud-

[1] Annual Report N. Y. P. S. Commission, First District, 1912, vol. ii, and 1913, vol. ii.

son Tunnel uptown tubes offered a fairly long ride, at high speed, and were undoubtedly popular for that reason. In spite of the traffic losses, the increase in fares (from 5 to 7 cts.) was sufficient to increase the gross revenue. This particular case is

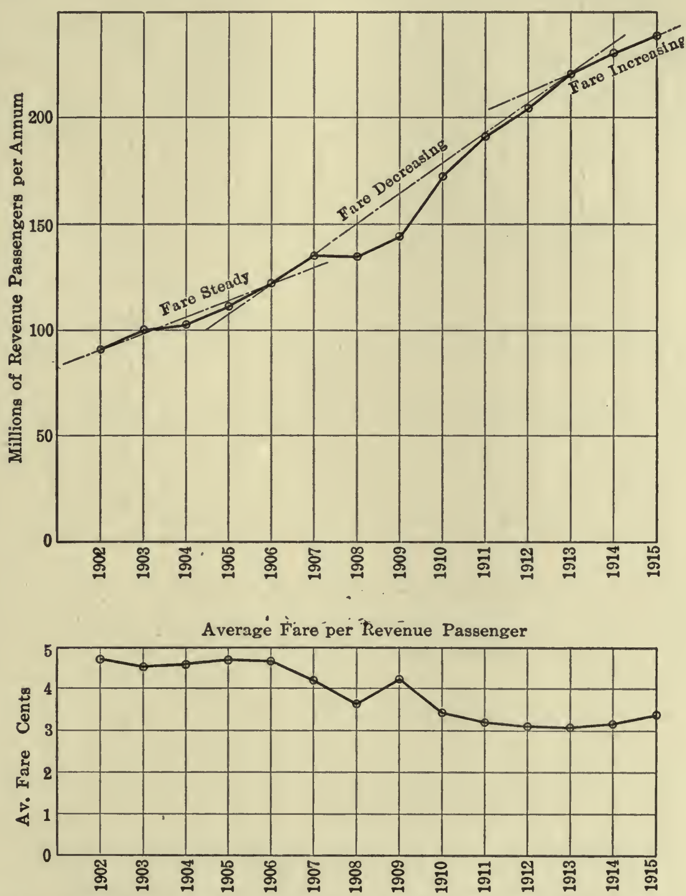

FIG. 47.—Cleveland, Ohio. Growth of traffic compared with changes in rate of fare.

presented here only as further substantiation of the fundamental fact that increased flat-rate fares cause traffic losses.

Decreased Fares Accompanied by Traffic Increases.—While increases in fares seem to be invariably accompanied by decreasing traffic, decreased fares, in the few cases for which reliable data are available, seem to be accompanied by increased traffic, or accelerated rates of increase in cases where the growth has been going on continuously. The statistical charts, Figs. 47 to 50, indicate this condition without requiring any special explanation. In the case of Cleveland, Fig. 47, the drop in traffic which appeared to accompany reduced fares in 1907–08, was due to competition by new lines, and to the general demoralization of the service. After the agreement between the company and the city occurred, the traffic was greatly increased.

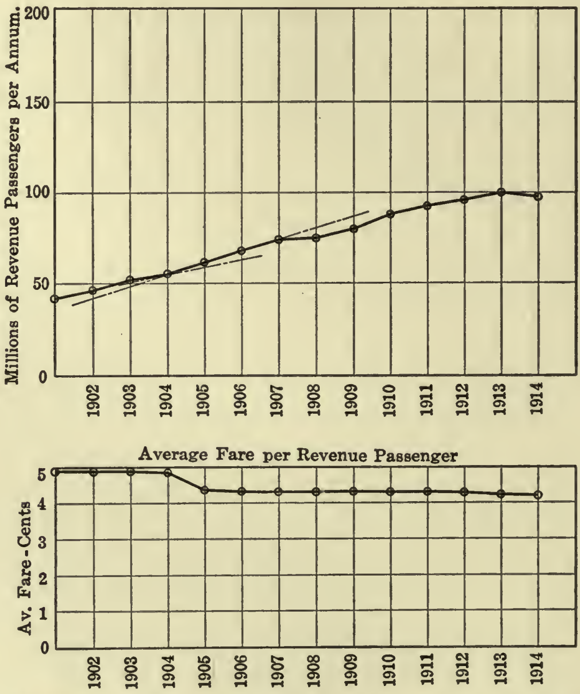

FIG. 48.—Milwaukee, Wis. Growth of traffic compared with changes in rate of fare. (City lines only.)

Conclusions.—Quite aside from the question of the effect on gross and net revenues, it is evident that increased fares decrease traffic, while decreased fares increase traffic. In the case of increased flat-rate fares, such as from 5 to 6 or 7 cts., it is reasonable to suppose that much of the loss occurs among the short riders who were already profitable at 5-ct. fares, and who object to being made more profitable for the benefit of long riders. If any of the long riders are lost when fares are increased, their loss is less serious because there is little or no profit in long riders even at 6-ct. fares.

In the case of the traffic increases which accompany decreased fares, it may be that the number of long riders is somewhat increased as well as short riders. Undoubtedly the lower fare unit induces many people to use the cars for short trips, where formerly they would walk. In general, a flat reduction in fares of say 40 per cent. (from 5 to 3 cts.) is more than any ordinary street railway can stand and continue to give service, unless

Lines on which Average Fare Decreased

Line	Av. Fare per Rev. Passenger			Number of Revenue Passengers		
	1913	1914	1915	1913	1914	1915
No. Milwaukee (12th St.)	4.33¢	3.25¢	2.96¢	504,812	507,069	547,626
Wanderer's Rest (Walnut St.)	4.99¢	3.56¢	3.35¢	132,113	142,998	151,925
Wauwautosa (Walnut St.)	4.17¢	2.08¢	1.90¢	307,728	348,952	326,364 *
Wauwautosa (Wells St.)	3.97¢	2.95¢	2.65¢	747,681	769,665	776,918
West Allis (Burnham)	3.90¢	3.56¢	3.49¢	554,668	542,289 *	553,160
West Allis (Fond-du-Lac)	3.79¢	3.26¢	3.29¢	906,837	919,896	905,682 *
Fox Point (Oakland)	5.00¢	3.47¢	2.94¢	86,968	104,507	92,667 *

* Traffic Decreased

Lines on which Average Fare Increased

Line	Av. Fare per Rev. Passenger			Number of Revenue Passengers		
	1913	1914	1915	1913	1914	1915
Whitefish Bay (Oakland)	4.58¢	5.04¢	5.34¢	478,864	411,353	297,593
St. Francis – Cudahy – So. Milw.	4.36¢	5.87¢	4.69¢	2,232,151	1,935,978	1,973,387 †

† This increase in traffic accompanies a reduction in the av. fare of the year 1915 over the year 1914, although still higher than the year 1913

FIG. 49.—Milwaukee, Wis. Growth of traffic compared with changes in rate of fare. (Suburban lines.)

the length of ride is properly limited. It would take a two-thirds (66⅔ per cent.) increase in traffic at 3-ct. fares to return the same gross revenue which was obtained from the larger fare unit. Such an increase in traffic for the ordinary street railway could scarcely be gained for many years, and even if it were, it would undoubtedly require such an increased use of equipment that operating expenses would be materially increased.

In past experiments in revising rates of fare on American street railways, it appears that a fundamental mistake has been made because of the attempt to continue the application of one universal fare unit to a very large area or to a very considerable length of line. If a company is prosperous, a decrease in the fare unit may be a wise move, and prove beneficial to both the public and the railway, provided the fare unit is made lower for the short riders, but not for the long riders. On the other hand,

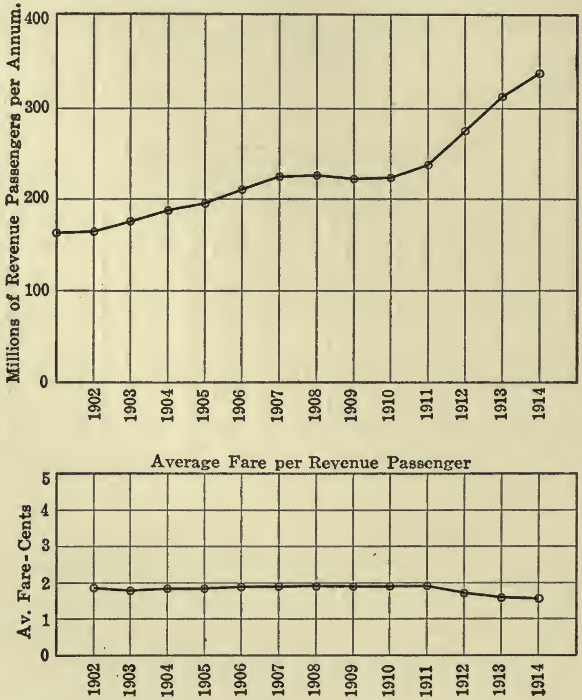

FIG. 50.—Glasgow, Scotland. Growth of traffic compared with changes in rate of fare.

a company which is financially embarrassed because of inadequate revenue at the 5-ct. fare may do well to increase fares, provided it does so for the long riders and not for the short riders. Then if any traffic is lost, it will be from among the ranks of the already unprofitable traffic which can best be spared.

CHAPTER V

LIFE CURVE METHOD OF ANALYSIS

Increases and Decreases in Expenses.—From the beginning of this research, the attention of the investigators has been called repeatedly to the increases in the costs of the material and labor entering into electric railway construction, equipment and operation. Articles in the railway press, papers presented to various associations and the direct testimony of street railway men have all been in agreement as to the positive nature, if not the amount, of these increases. It is scarcely necessary to quote here any tables and lists of statistics showing these increases. The wide publicity given to recent wage arbitration proceedings has provided ample testimony for the public as to the higher pay of car-service employees. The prices of iron, steel, copper and lumber are fluctuating in nature, but generally upward. Naturally all of these cost increases have a very definite tendency to increase the costs of building and operating street railways, and associated with these have come higher tax levies. At the present date abnormally high prices for metals and building materials prevail because of economic conditions imposed by the war in Europe, but our data relate to the period antecedent to the conflict.

On the other hand, improvements in machinery, in power plants, and in methods of power distribution, larger and faster cars and more efficient methods in car service and routing have all had a constant tendency to reduce the cost of operation.

Since these several increases and decreases tend to balance each other, the real question at issue is to find out what the net change has been, bearing in mind always, that the fundamental object of such a study is to learn all the facts bearing upon the relation of fares to the total costs of service.

Statistical Units.—Tables and charts of statistics showing the growth—over a number of years—of total receipts and the various items of expense are not satisfactory exhibits in a discussion such as this, for they deal in such large quantities that the mind cannot readily grasp the significance of each item and its relation to the others. One is apt to be greatly impressed with the tremendous increase during the past 20 years of an item like taxes, and is apt to forget that perhaps the value of property upon which these taxes are levied has increased in like proportion. It has seemed that these statistics of annual variations can be more significantly portrayed by referring all figures to fundamental unit bases. Derived statistics can be made the basis of comparisons and conclusions more readily than gross totals. The principal unit chosen for this analysis has been the "revenue passenger." The car-mile, and the mile of single main track units, have also been used for demonstrating certain particular points.

The choice of the revenue passenger unit for demonstrating the main points of this analysis has been made after some deliberation. The principal business of the street railway is to carry passengers and its gross revenue is generally derived almost wholly from fare-paying passengers. Consequently, the passenger is the most fundamental unit in the operation of a street railway. The total number of cars operated, the car-miles, car-hours, the miles of track, the kilowatt-hours of power consumed, the total gross revenue and even the total investment, are primarily dependent upon the number of passengers carried. The "nickel" fare is not of itself a wholly satisfactory unit, because it is the chief factor in question in this investigation, and because many roads have special fares not equal to 5 cts., some higher and some lower. It was decided, therefore, to base a comparative study of the history of receipts, expenses and investment since 1890, upon the "revenue passenger" as a unit, with certain related statistics based upon other appropriate units.

Life Curves of Street Railways.—In order to demonstrate the variations from year to year of receipts, expenses and investment per revenue passenger, statistical charts which have been termed "life curves" have been developed during the course of this research. Life curves for a number of individual roads have been drawn up, chiefly among Massachusetts companies, because the actual investments involved could be most readily determined in this State. The annual reports of Massachusetts Railroad Commission[1] from 1890 to the present time have been used in this work, and in some cases additional data or informa-

[1] Now known as the Massachusetts Public Service Commission.

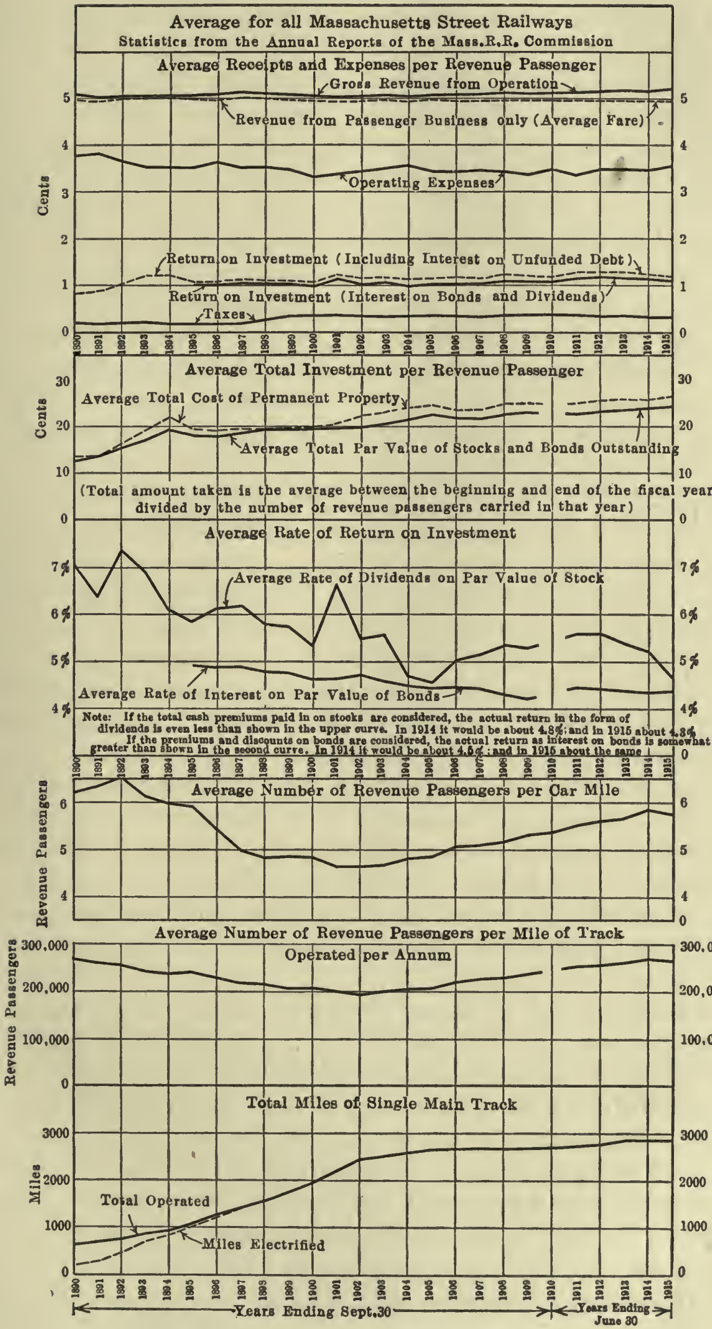

FIG. 51.—Massachusetts street railway statistics.

tion have been obtained by direct application to the individual companies.

Fig. 51 represents a set of life curves for the average of all the street railways in Massachusetts, combined as though in one single complete system. In other words, the total receipts, total expenses, total passengers carried, etc., on all the roads in the State, for each fiscal year, have been used in making up these curves. By using these general averages, minor fluctuations and variations which are met with in the statistics of individual companies are smoothed out, and the general tendencies are brought out more distinctly. To be sure, certain individual roads' statistics may be found to vary somewhat from the averages shown in Fig. 51, but they will be mostly among the smaller roads. Certainly, these averages correctly represent the general conditions affecting the great bulk of street railway investments today, at least in Massachusetts, and since the street railway is an old and well-established industry in that State, the results may perhaps be considered as indicative of general conditions in the country. The almost total lack of reliable records outside of Massachusetts as to actual investments in past years, makes it impossible to make similar general studies in other States.

The most striking and significant point brought out by this life curve study is the steady increase in the "investment-per-revenue-passenger" and the decrease in the average rate of return since the horse-car period of 1890. The statistics of the majority of the larger companies in Massachusetts are found to follow this tendency. A few are exceptions, of course. There are one or two medium-sized companies which are enjoying reasonable prosperity and which have succeeded by fortunate circumstances and cautious management, in keeping their investment low.

It is significant, however, that when the investments and rates of return of all Massachusetts roads are combined (Fig. 51), the steady investment increase, and rate of return decrease are plainly marked. The report of the Massachusetts Public Service Commission for the year ending June 30, 1915, showed that out of 53 companies, 20 declared and paid no dividends for that year, and of the 33 which made some payment, only 14 paid 6 per cent. or over on their common stock. For the year ending June 30, 1914, the showing was nearly as poor. Out of 54 companies, 19 declared and paid no dividends, and of the 35 which made some payment, only 17 paid 6 per cent. or over on their common stock. If this common stock could be classed as "watered stock" the failure to earn a return upon it would not be a matter of concern, but when it actually represents a cash investment in so vital an interest as transportation, as it does in Massachusetts, it becomes a matter worthy of serious consideration. If the transportation business in general is becoming unprofitable because of inability to charge self-supporting rates for service rendered, then private capital and enterprise will cease to aid in the development and improvement of transportation and its support will fall on the already over-burdened general tax payer.

Referring to the life curves:

Revenue.—As might be expected, "Passenger Revenue" has remained practically constant at about 5 cts. per revenue passenger carried ever since 1890, because the unit fare has remained at 5 cts. "Gross Revenue from All Sources" when divided by the number of revenue passengers, naturally comes to a trifle over 5 cts., and in recent years has shown a small increase on some roads, due to the growing business of carrying milk, express, freight, etc. In the method of analysis presented by these life curves, we may consider this as just so much extra revenue per passenger, as the various expenses connected with obtaining this revenue are included with the passenger expenses, taxes and investment, and cannot be separated without close and expensive investigation.

Operating Expenses.—"Operating Expenses" *per revenue passenger* on the whole cannot be said to have shown any general increase over what they were in 1890. For several roads they are somewhat lower, and the average of all Massachusetts roads is lower. This holding down of operating expenses has been due largely to the efforts of the street railway managers and operating officials to increase their efficiency at every possible point, in which they have also been assisted by the advancement of the art caused by inventions and improvements in manufactured products. Had the railways not, in this way, overcome the effects of greatly increased wages of carmen and higher costs of material, it is not unlikely that the present operating expenses alone would be nearly equal to the passenger revenue at a 5-ct. fare.

It is worthy of notice that although the present level of the average curve of "Operating Expenses" per revenue passenger in the life curves is, in many cases, lower than it was in 1890, the trend of this curve in recent years is upward. The general conclusion that may be drawn by a study of the "Operating Expense" curve is that in the first few years after 1890, the introduction of electricity as a motive power resulted in lessening cost of street railway operation, but subsequent improvements and increasing efficiency have been offset by increases in wages and materials, by longer rides and better service; and the time seems to have come when the increases are overbalancing the decreases. At the present time, the average "Operating Expenses" per revenue passenger for all Massachusetts roads is approximately 3.6 cts.[1] In all probability the item of operating expenses will continue to increase unless some radical improvement in the art is discovered, or the average length of haul for a single fare is reduced. There is a steady movement all over the country for higher pay for motormen and conductors, and this movement often has the sympathy and support of public opinion. It seems only right that the men responsible for handling the street railway cars, the men who, as representatives of the street railway company, are in direct contact with the riding public and responsible for their safety, should have not only a living wage, but something a little better than a mere living wage. But when the public is in a frame of mind to support such an opinion, it has to remember that this extra contribution to the men must be paid by the public itself through the fares to the company. Prof. Irving Fisher of Yale University, an authority on economics, when testifying as an expert witness for the employees at the wage arbitration proceedings between the carmen's union and the Bay State Street Railway Company in February, 1915, claimed that the cost of living is advancing faster than the employees' wages, and he favored the increase which the men were seeking, even if the company's financial condition were unsatisfactory. He was reported in the daily press as saying,

"If inability to pay (the higher wages) exists, it is remediable as in ordinary business, by raising the prices charged to the public. Otherwise, the workmen are being asked to make a gift of their just wages

[1] A wide range of operating expenses per revenue passenger is indicated by the data and by the text and figures in connection with density of traffic *vs.* operating expense, Chapter II, p. 18. See also Figs. 6, 7 and 8. Some figures for various individual companies are given in Chapter VI, Table IV.

to the public. . . . I have little doubt that whatever may be the truth in the present case, the future will find many trolley companies forced to raise their fares above 5 cts."[1]

Taxes.—"Taxes," which have so frequently been complained of by street railway owners and operators, evidently consume a considerable portion of the total fare which is paid into the street railways. At the present time, this item ranges from about 0.2 to 0.4 ct. or a little more per revenue passenger, for the different companies. Expressed in another way, these figures represent a tax charge of from about 4 to 8 per cent. of the fares of the passengers. The increase in this item since 1890, while not very great, is plainly marked. The indirect taxes, such as street paving and similar requirements, paid for by the railways, do not appear in this item, but are included in interest on investment and operating expenses.

Return on Investment.—Money paid as "Return on Investment" has also been plotted on the revenue-passenger basis. This item includes dividends, interest on funded debt and rentals for leased roads, and the supplementary dotted line includes interest paid on unfunded loans and notes. Trackage rentals and minor rents of buildings, etc., are not included, as they are retained in operating expenses.

Omitting all roads outside of Massachusetts for lack of accurate knowledge of the actual investment, the curves show little or no increase in the amount available as "Return on Investment" per revenue passenger carried since 1890. They show that for every passenger carried, practically the same amount of return on investment is being paid today as in the earliest days of electric railroading, this amount being about 1 to 1¼ cts. per revenue passenger, and the investment per revenue passenger is larger.

Investment per Revenue Passenger.—The "investment per revenue passenger carried per annum," as of the present time, was shown in Chapter II, to bear an approximate relation to density of traffic when the statistics of a fairly large number of roads were analyzed. It is interesting and significant to note that for the average street railway, there has been a material

[1] Prof. A. S. Richey of Worcester Polytechnic Institute, a consulting engineer for the Bay State Street Railway Company, took exception to some of the figures and statistics offered by Prof. Fisher, and presented many exhibits tending to show that rents and food prices in a number of Massachusetts cities and towns were not so high as estimated by Prof. Fisher.

increase in the size of this unit of investment since the days of the horse-car, and in this life-curve study the changes in this unit have been brought out.

Curves showing the changes in this unit of investment since 1890 are plotted in Fig. 51, in the second section from the top of the chart. Two curves which check each other fairly closely are shown. The most significant one is the dotted line, entitled "Total Cost of Permanent Property" per revenue passenger carried per annum. The points for each year were obtained by dividing the average total investment in permanent property, as shown by the asset side of the companies' balance sheets (this according to Massachusetts laws being the actual money in the property), by the number of revenue passengers carried during that year. The other curve, shown by the full line, was similarly obtained, by using the total of the outstanding stock and bonds as shown by the liability side of the balance sheet. Where the dotted curve showing "Total Cost of Permanent Property" is higher than the one showing "Total Par Value of Stocks and Bonds," the difference will be found in the existence of an unfunded debt on which interest is paid by the company, as indicated in the expense curves on the life-curve charts, and also by the fact that in some cases premiums were received on the sale of new stock and bonds. These premiums went into the companies' treasuries and were invested in new property.

Decreased Rate of Return.—It must be perfectly evident that where investment is increasing and money paid as return on investment does not increase in like proportion, then the *average rate per cent. of return must be decreasing*, as actually shown on the chart of the average for all Massachusetts roads.

Causes of Increased Investment.—Much consideration has been given to the problem of why the average investment per passenger carried has increased.

The following actual conditions met with in the history and experience of Massachusetts companies apparently have tended to increase the total cash investment per revenue passenger carried per annum by those companies:

1. Higher costs of the labor and materials of construction.
2. Improved plant of all kinds which now has a higher first cost.
3. Longer rides for single 5-ct. fares, which tend to require more track-miles and more car-miles for a given number of passengers carried per year, thus virtually decreasing traffic density.

4. Extension and operation of lines in sparsely settled regions where the density of traffic is still too light to make the service self-supporting.
5. Failure to provide for renewals of depreciated property and replacing of obsolescent property by money obtained from earnings.

With regard to items (1) and (2) above, Table II which was made up from the statistics in the annual reports of the Massachusetts Railroad Commission is especially significant.

TABLE II

Average cost per mile of main track of all Massachusetts street railways					Average gross revenue per mile of main track	Average number of cars and other vehicles per mile of main track
Year	Construction of road and track	Equipment	Other permanent property	Total cost per mile		
1890	$17,335	$10,658	$11,415	$39,408	$13,632	6.2
1891	17,919	11,614	12,202	41,735	13,178	6.1
1892	19,520	15,215	12,558	47,293	12,980	5.6
1893	26,792	11,739	15,455	53,986	12,392	5.4
1894	26,748	11,528	15,356	53,632	11,972	6.3
1895	23,984	10,479	14,266	48,729	12,127	5.7
1896	23,396	9,805	12,840	46,041	11,627	5.3
1897	22,755	9,374	12,329	44,458	11,187	5.2
1898	22,537	8,957	11,735	43,229	10,998	5.0
1899	22,863	8,518	11,598	42,979	10,459	4.7
1900	23,443	8,510	11,684	43,637	10,452	4.6
1901	23,953	8,678	11,666	44,297	9,998	4.4
1902	24,495	9,026	11,889	45,410	9,609	4.0
1903	26,015	9,994	12,546	48,555	10,124	4.0
1904	27,025	10,177	13,106	50,308	10,178	3.9
1905	27,876	10,112	13,321	51,309	10,300	3.9
1906	28,974	10,212	13,616	52,802	11,156	3.9
1907	30,064	10,801	14,563	55,428	11,485	3.9
1908	31,005	11,103	15,569	57,677	11,507	3.9
1909	31,747	11,076	15,757	58,580	11,899	3.9
1910	32,484	11,654	17,594	61,732	8,892	3.9
1911	36,216	11,760	16,250	64,226	12,877	3.9
1912	37,350	12,287	18,866	68,503	13,148	4.0
1913	37,294	12,270	19,317	68,881	13,461	3.9
1914	37,882	13,112	19,652	70,646	14,017	4.0
1915	39,895	13,370	17,639	70,904	13,839	3.8

The most striking fact made evident by this table is that while the average total cost of permanent property per mile of main track for Massachusetts street railways has nearly doubled, from $39,408 in 1890 to $70,904 in 1915, the gross revenue per mile of main track has actually decreased, until the last 2 years when a slight gain was shown. The greatest increase has been in the construction cost per mile of main track. This item covers cost of actually building the roadbed, laying the tracks, and installing the overhead line. That condition (2)—higher first cost of improved equipment—is true, is also evidenced by the slightly increased cost of equipment per mile of main track, while the actual average number of cars used per mile of track is considerably less. In other words, the cost of the more recent types of cars is much greater than that of the old ones.

Effect of Longer Rides.—Condition (3), regarding longer rides, is somewhat difficult of direct proof in that there are no data available as to the average lengths of ride on street railway lines, except in very recent years. Some light is thrown upon this question, however, by the two sets of curves depicting density of traffic, *i.e.*, the "Revenue Passengers per Mile of Main Track per Annum" and the "Revenue Passengers per Car-mile" curves. Referring to Fig. 51, we observe that the points on both of these curves are as low or lower at the present time than in 1890. The big decreases indicated by these two curves during the first few years may be explained by the rapid extension of city lines into suburban districts, and the construction of interurban lines during and just after the time of electrification. Combinations of previously independent lines resulted in transfer privileges between them instead of double fares as heretofore, thus reducing the number of fare-paying passengers. Cars were run further and further out into thinly settled suburbs, and the railway promoters usually acceded to demands for the extension of single-fare limits, as they hoped for immediate traffic increases which frequently failed to materialize. Meanwhile the cars were carrying a given number of people longer distances than ever before for the same rate of fare. Consequently the "Average Number of Revenue Passengers per Car-mile" fell off rapidly. In recent years the use of larger cars, carrying more passengers per trip than the older types, has started this curve on the upward direction again, although the long rides, generally speaking, appear to be still on the increase, and single fare limits have seldom been decreased.

As to condition (4), namely the extension of lines into sparsely settled regions where the density of traffic is still too light to make the service self-supporting, the remarks in the preceding paragraph relating to changes in density of traffic are equally applicable. It was clearly demonstrated in Chapter II that the cost of service per passenger decreases as the density of traffic increases, and *vice versa*. Likewise, when extensions of existing systems decrease the numbers of passengers per car-mile, or per mile of track per annum, the investment per revenue passenger is increased. The curves for nearly all the roads now show a slowly increasing tendency in the density of passenger traffic, and it is to be hoped that with the growth of population, the ratio of revenue to investment may increase, so that improved conditions of operating may be brought to pass. The last few years, however, of business depression prior to the European war, combined with jitney competition, have tended to retard, if not wholly stop, the increases in traffic density.

Depreciation and Obsolescence.—The four conditions tending to higher investment as discussed above, have all been more or less outside the control of the street railway men. The last condition, namely renewals and replacements, has not been so much beyond their immediate control.

Repairs and piecemeal replacements of equipment and other property may keep it in use for many years, and in some classes of property almost indefinitely. These repairs and piecemeal replacements are generally and properly charged to operating expenses. In the rapid progress of the art of electric traction, much property has become obsolete and has been virtually abandoned, new property being purchased to take its place. Proper accounting treatment requires that the value of property abandoned because of depreciation or obsolescence be removed from the book value of property and the money for writing it off should be obtained from operating earnings.[1] This money should then be used to purchase the new property, to renew or

[1] It is sometimes claimed that property which is still capable of service, but unused because it is of obsolete type, should not be charged off out of earnings, but is properly a capital "cost of development." It would be difficult to draw the line if this claim were admitted, and the result would probably be a tremendous amount of useless property carried on the books. The cost, if too large to charge out of earnings in one year, should be amortized gradually.

replace the old. In this way, the capital account is increased by the change only in case the new property costs more than the old. This method has not always been adhered to by the street railway companies in this country. Not infrequently, every scrap of new property has been charged up to new capital without the writing off of old replaced property. In Massachusetts, it has not been so bad, as the Commission would never permit the capitalization of self-evident replacements, but many roads are still carrying on their books the original costs of old cars and power equipment which are still in existence, but are practically useless. In the car houses of many roads there may still be found old single-truck cars, seldom or never seen out on the road, but still part of the equipment value carried on the books of the company. The Commission in Massachusetts now requires that companies show some annual charge for depreciation, but the proper amount is left to the discretion of the companies. However, it is not likely that the present property will hereafter be allowed to depreciate without some reasonably adequate provision for its replacement out of earnings.

This required annual provision for renewals and replacements means another increase in operating expenses which the railways will have to meet. Not all companies have neglected it in the past; in fact all those especially studied have made some payments for renewals and reconstruction more or less irregularly in addition to regular maintenance charges, taking the money from operating revenues instead of making the renewals from capital funds, but in only a few cases does this matter appear to have been adequately handled out of earnings.

In extenuation of failure to make more adequate allowances from earnings for renewals and replacements, it has been urged in many cases that there were no funds available for making such allowances unless return on investment were to be suspended. This is probably true. The present surplus accounts carried by most Massachusetts companies are very moderate. To have further reduced or suspended the return on investment in the past would have immediately stopped the inflow of new capital, which was necessary for legitimate extensions and improvements, unless fares were raised. In the recent Manchester fare case,[1] the New Hampshire Railroad Commission allowed the

[1] Decided Nov. 20, 1914, N. H. Public Service Commission. See Reports and Orders of the N. H. Public Service Commission, vol. v, No. 2, p. 75.

full undepreciated value of the Manchester Street Railway Co. as the basis of rate-making, on the ground that, although the company had failed to fully offset this depreciation by renewals or reserves therefor, its revenues from existing traffic and fares had been too low to make such provision and pay an adequate return on its bona fide cash investment. A similar policy has been maintained by the Massachusetts Public Service Commission.

As to just how far a public utility company is justified in paying a return on investment and neglecting to charge renewals to expense, where revenues are inadequate to provide for both, is a delicate question with which the courts and commissions are still wrestling. To suspend the payment of regular and adequate interest and dividends on actual investment, will immediately depreciate the market value of securities, and it becomes practically impossible to secure additional capital under these circumstances. On the other hand, if maintenance is deferred, and no renewals, or reserves for future renewals, are made out of annual earnings, this practice, if continued for any substantial period, will result in a run-down condition of property and will ultimately bankrupt the company, or else impose an excess, and probably undeserved burden of expense on future generations of riders. In fixing fair rates for present-day riders, each individual street railway's history is an important factor.

Conclusions from Life Curves.—The most fundamental conclusion which may be drawn from this life-curve analysis is that in Massachusetts, at least, where the street railway is an old and well-established industry, the average rate of return on actual investment has declined materially until at the present time an average return of only about 4.5 per cent. is being paid on the total money investment in all the street railways in the State, and the tendency appears to be steadily downward. Operating expenses, including renewals and replacements, in nearly every case have been taking increased proportions of each passenger's fare in the last few years, although in some cases this item is not yet as large as it was in 1890. The growth of the actual investment involved in the transportation of each passenger, for the reasons enumerated in the preceding text, without a corresponding increase in the amount of each passenger's fare available for return has plainly decreased the average rate of return.

While all the systems studied do not show the same characteristics over the whole period of years, the tendencies in the last few years are becoming not only more similar, but the actual amounts per revenue passenger are approaching certain fairly comparable levels. Such variations as exist are due largely to differences in density of traffic as more fully demonstrated in Chapter II by means of available traffic figures.

It must be plain that if present tendencies continue, that is, if operating expenses continue to take as much or more of each passenger's fare, and rate of return continues to decline, then one of two things must happen: Either the improvement and development of the street railway industry must come to a dead stop for lack of new capital, or else the average fare per passenger-mile must be increased. This is a general statement of average conditions and does not apply to every individual system, neither is it to be construed as a blanket recommendation for a horizontal advance in fares.

CHAPTER VI

THE DIVISION OF THE AVERAGE PASSENGER'S FARE

To show how the street railway disposes of its gross revenue, which is mostly derived from the collection of fares, the statistics of receipts and expenses reduced to the *revenue-passenger unit* furnishes a most illuminating and useful form of information. The method is simply one of division. The total expense for some particular item or class of items, in any given year, is divided by the number of revenue passengers carried that year, the quotient being the *expense per revenue passenger.* For example, if a street railway does a passenger business only, at straight 5-ct. fares, its gross revenue will be 5 cts. per *revenue passenger* (hereafter designated by the initials r.p.) Operating expenses may be about 3.5 cts. per r.p. (corresponding to an operating ratio of 70 per cent.), taxes may be say 0.3 ct. per r.p. There will then remain 1.2 cts. per r.p. available for return on investment. The amount actually paid out as return on investment may be more or less than this remainder; if more, there will be a deficit, if less, a surplus, for the year's account. The percentage rate of return on the investment represented by this 1.2 cts. per r.p. will depend, of course, on the size of the investment per r.p.[1] If for example, 27 cts. per r.p. fairly represents the total investment involved in the property, then 1.2 cts. per r.p. would equal an average return of 4.44 per cent. (*i.e.*, the ratio of 1.2 to 27.0 expressed as percentage). Fig. 52 represents the division of the nickel, in accordance with these assumed figures.

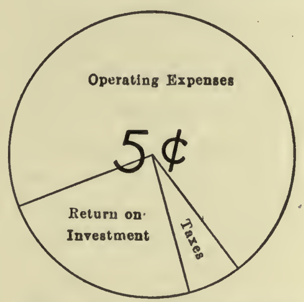

FIG. 52.—Division of the nickel under conditions assumed in chapter VI.

The figures mentioned in the preceding paragraph are used merely as illustrations, but they are approximately typical of

[1] See Chapter II.

the average of Massachusetts roads. As was shown in Chapter II, the most important factor affecting the average cost of service per r.p. is the density of traffic. It was shown there, that while average operating expenses per car-mile vary to some extent among different street railways, there is an approximate general correspondence, the majority of all ordinary street railways spending from 16 to 23 cts. per car-mile. Likewise, it was shown that the size of the investment, subject though it is to many other influences, has a certain relation to the density of traffic. Consequently, the operating expenses and the return on investment per r.p. carried, depend largely upon the density of traffic.

In the statistics accompanying this chapter, an effort has been made to use companies which are engaged almost wholly in passenger business only, so that the figures per r.p. will not be distorted by the inclusion of receipts and expenses for transporting other kinds of traffic. Nevertheless, practically every street railway of any size has a certain amount of revenue derived from other sources than passengers, such for instance as advertising, carrying mail, express and freight. In the accompanying statistics, the passenger revenue per r.p. will be shown, followed by the revenue from other forms of transportation and miscellaneous sources also reduced to the r.p. unit. No attempt can be made, in such general statistics, to separate expenses between passenger and other kinds of transportation; consequently, as stated above, the statistics used are confined to those street railways on which the transportation of other than passenger traffic is so small as to be negligible in the final results. The following figures, it will be understood, are the actual statistics of operating companies, and the return upon investment, instead of being determined at some "fair" rate, is simply the balance that is left from revenue, at a fixed rate of fare, after operating expenses and taxes are paid.

In Table III, there are given the average statistics of all Massachusetts street railways combined, for the fiscal year ending June 30, 1915, in the same form as used for the statistics of certain individual companies in Table IV.

From such an analysis as this, the passenger, or any other student of the situation, may see at a glance the average way in which the individual fare is utilized in meeting the costs of service. One striking point is brought out in reference to the wages of motormen and conductors. This single item claims, on the average, more than 1 ct. out of every 5-ct. fare. Maintenance and renewals claim nearly another cent, and in many cases the actual expenditures and allowances for these items are insufficient. Power costs about 0.5 ct. per r.p. as an average for the whole street railway system in Massachusetts. By far the greater part of this power is generated by the street railway companies themselves, and so this cost represents practically only the operating cost of generation and distribution. Injuries and damage claims absorb nearly 0.25 ct. out of every fare, which means that the millions of passengers who use the street railways every day without injury or damage of any sort, are obliged to contribute substantially a quarter of a cent every time they do ride, to pay the claims of the tens or possibly hundreds of passengers and others who meet with real or simulated injuries. The total actual operating expenses come to a little more than 3.5 cts. per r.p. in this general average for all Massachusetts street railways.

Interest and dividends use up 1.29 cts. per r.p.; and figured on the total stocks, bonds and unfunded debt plus net premiums and discounts, this equalled 4.5 per cent. average return on actual cash investment in the street railways of Massachusetts in 1915.

The total costs of all items aggregate 5.23 cts. per r.p., while the average fare per r.p. is only 4.96 cts.[1] In addition to passenger fares, however, the Massachusetts railways receive from other sources, revenue and income to an amount averaging 0.25 ct. per r.p., so that the final results practically balance.

It is clear, however, that an average return on investment of only 4.5 per cent. is insufficient. Street railway bonds, at this rate, are today being sold at a price to yield about 5 per cent. To make possible the sale of stock with its attendant financial risks and responsibilities of management, a rate of return materially higher than bond interest must be earned.[2]

If 6 per cent. be taken as an estimate of what may be called a fair average return under Massachusetts conditions, the amount per r.p. for return on investment would be increased from 1.29 to 1.72 cts., or an added requirement of nearly 0.5 ct. per pas-

[1] Although 5 cts. is the usual fare in Massachusetts, there are some workmen's, school children's and other special rates less than 5 cts., also some 6-ct. fares.

[2] See discussion on "Investment and Rate of Return," Chapter I, pp. 4–6.

senger. If a 7 per cent. rate of return be used, 2.00 cts. would be required instead of 1.29 cts. Maintenance and renewals at 0.92 ct. per r.p. and 5.31 cts. per car-mile can hardly be called adequate in view of the present condition of roadbed and equipment on many of the Massachusetts street railways. Few of the street railways have been putting aside anything in the past for the ultimate replacement of rolling stock. A considerable increase in the maintenance and renewal allowances could be made by the addition of 0.2 or 0.3 ct. to each passenger's fare.

The foregoing remarks are not to be construed as a recommendation for a general increase of fares in Massachusetts.

TABLE III.—DIVISION OF THE AVERAGE PASSENGER'S FARE

Average Statistics of All Massachusetts Street Railways as though Comprised in One System

Year ending June 30, 1915

Total Number of Revenue Passengers carried, 760,464,372

	Cents per revenue passenger	
1. Maintenance and renewals of way and structures and equipment	0.92	
2. Traffic (advertising)	0.02	
3. Power	0.54	
4. Motormen and conductors	1.14	
5. Other transportation expenses	0.40	
6. Injuries and damages	0.23	
7. General and miscellaneous	0.33	
8. Total operating expenses including renewals	3.58	
9. Taxes	0.32	
10. Interest on funded and floating debt (including Boston subways)	0.68	1.29
11. Dividends (including rentals of leased roads)	0.61	
12. Miscellaneous expenses and charges	0.04	
13. Total expenses and charges	5.23+	
14. Passenger revenue	4.96	
15. Other revenue and income	0.27	
16. Total revenue and income	5.23+	
17. Actual surplus (+) or deficit (−)	−0.00+	
18. Average rate of return on total investment	4.5 per cent.	
19. Maintenance and renewals, cents per car-mile	5.31	

TABLE IV.—THE DIVISION OF THE AVERAGE FARE AMONG VARIOUS ELEMENTS OF EXPENSE

	Boston Elevated Ry. (Mass.) (a)	Holyoke Street Ry. (Mass.)	Springfield Street Ry. (Mass.)	Union Street Ry. (Mass.)	Worcester Consolidated Street Ry. (Mass.)
Date of statistics, year ending	June 30, 1915	June 30, 1915	June 30, 1915	June 30, 1915	June 30, 1915
Miles of single main track operated	450	66.5	174	61	282
Revenue passengers carried per year	346,316,584	12,368,399	41,056,456	18,759,118	53,083,490
Passenger receipts per r.p., cts	4.99	4.98	4.94	4.82	4.93
Other revenue and income per r.p., cts	0.17	0.27	0.24	0.40	0.23
Total revenue and income per r.p., cts	5.16	5.25	5.18	5.22	5.16
Operating expenses, including renewals, per r.p.:					
Maintenance and renewals, cts., per r.p. (c)	0.80	0.91	0.90	1.58(b)	1.20
Traffic (advertising), cts., per r.p	0.00+	(Cr.0.08)	0.01	0.07	0.02
Power, cts., per r.p	0.33	0.70	0.68	0.46	0.54
Motormen and conductors, cts., per r.p	1.15	1.17	1.30	1.08	1.05
Other transportation expenses, cts., per r.p	0.47	0.28	0.30	0.47	0.24
Injuries and damages, cts., per r.p	0.24	0.30	0.36	0.15	0.25
Other general expenses, cts., per r.p	0.27	0.41	0.28	0.33	0.25
Total operating expenses, per r.p., cts	3.26	3.69	3.83	4.14	3.55
Taxes, cts., per r.p	0.31	0.41	0.33	0.44	0.33
Interest on funded and floating debt, cts., per r.p	0.30	0.37	0.42	0.11	0.68
Dividends, cts., per r.p	0.38	0.87	0.59	0.69	0.53
Rentals of leased roads, cts., per r.p	0.91(a)	0.05	....	....	0.05
Other miscellaneous expenses and charges, cts., per r.p.	0.01	....	....	Cr. 0.05	....
Total expenses and charges per r.p., cts	5.17	5.39	5.17	5.33	5.14
Total revenue and income per r.p. (as above), cts	5.16	5.25	5.18	5.22	5.16
Surplus(+) or deficit(−) per r.p., cts	−0.01	−0.14	+0.01	−0.11	+0.02

(a) Boston Elevated Ry., includes rented subways and tunnels.
(b) Includes debit to profit and loss for writing off value of land.
(c) Includes maintenance of power plant and equipment.

While many roads plainly need increased revenues, others do not. Moreover, it is not in line with the general recommendations and conclusions of this report to advocate either advances or decreases in unit fares, but to give the facts as they exist.

Similar statistics derived from the reports of certain individual companies are presented in Table IV. The approximate size of the railway and its traffic in each case may be judged from the preliminary figures showing miles of track and the annual number of revenue passengers carried. It will be noted that many of the individual companies' statistics vary materially from the averages for all Massachusetts companies because of different degrees of traffic density and different operating conditions.

CHAPTER VII

CLEVELAND'S 3-CT. FARE SYSTEM

A study was made early in 1916 with the intention of learning, as clearly as possible, the actual statistics and conditions of operation of the Cleveland Railway Co. and of presenting in simple form an analysis of the cost of service and the density of traffic. It is proposed to show just how the Cleveland Railway Co., under the provisions of an unusual city ordinance, and in coöperation with the city government, is running an urban street railway system at a very low rate of fare. Insofar as it has been feasible, actual statistics have been used for comparing the Cleveland situation with conditions in other cities. On some points, such as quality of service and condition of property, it has been necessary to offer opinions and observations, and these it is the reader's privilege to accept or to reject.

Findings on Cleveland Situation Briefly Summarized.—(These conclusions were based on the conditions found at the time this study was made.)

First.—The *average* fare per revenue passenger, including nickel cash fares, suburban fares and transfer charges, is and always has been more than 3 cts. In 1914, it was 3.25 cts. In 1915, it was 3.43 cts.

Second.—The actual total expenditures each year up to 1915 have been in excess of the gross receipts. In 1915 there was a surplus of revenue over expenditures in that year of 0.09 cts. per revenue passenger.

Third.—A high density of traffic is largely responsible for the present ability to run this system at approximately 3⅓-ct. fares. This high density of traffic is due partially to a fairly high density of population, partially to low fares, partially to frequent and good service, and partially to the absence of steam railroad suburban competition and freedom from jitney competition. Short riding, both in the suburbs and business districts, has been stimulated and is very noticeable.

Fourth.—The operating expenses per car-mile, including actual expenditures for maintenance and depreciation, are now about on a par with those in other city systems. The high density of traffic, expressed in terms of passengers per car-mile, keeps the operating expense per revenue passenger at a low figure. In 1915, actual operating expenses and depreciation charges amounted to 17.55 cts. per revenue car-mile,[1] or 2.49 cts. per revenue passenger. Taxes were nearly 6 per cent. of gross revenue and 0.20 cts. per revenue passenger.

[1] Using actual car-miles run.

Fifth.—Return on investment averages a little less than 6 per cent., due to a 5 per cent. interest rate on some outstanding bonds. Six per cent. is fairly sure to stockholders, the rate of fare being flexible, so as to insure this rate of dividends. The capital stock on which this return is paid was cut in 1908, from $23,400,000 par value to $12,870,000 (from $100 per share to $55) because of the value placed on the plant and business by the Goff-Johnson compromise settlement. The stock was not again changed as a result of the Tayler Ordinance in 1910. The total interest and dividend requirements per revenue passenger under these conditions were 0.77 ct. in 1915, and since 1910 have varied annually between 0.7 and 0.8 ct. Most paying city systems require at least 1 ct. per revenue passenger to maintain a fair return on investment. Possibly the Goff-Johnson valuation, and subsequently the Tayler valuation, were both unduly low, but here also, a high traffic density may be credited with keeping down the interest and dividend requirements per revenue passenger.

Sixth.—The quality of service appears to be about on a par with that observed on the majority of city systems, whatever their fare rate may be. It is probably true that service is better now than for several years past, because during the time that the density of traffic was being built up and the system rehabilitated, it was necessary to crowd the cars to keep the earnings per car-mile up to expenses.

Seventh.—The physical condition of the property appears to be good. Rolling stock is modern, and well-kept, and the track work has been largely renewed in the last 2 or 3 years. The company is now spending as much, per unit, for maintenance, as many other good city systems.

Eighth.—Because a low average rate of fare of approximately 3⅓ cts. per revenue passenger appears to be adequate in Cleveland, it does not follow that it is practicable in other cities without changing the fare areas. The Cleveland 3-ct. fare area extends only to a radius of about 4 miles on the west and south, about 5 or 6 miles on the southeast, and only on the northeast does it extend to 8 or 9 miles (see map, Fig. 36). Even here the danger is visible, and the former Street Railway Commissioner of Cleveland declared that he believed these northeast lines to be altogether too long for 3-ct. fares.

Ninth.—A substantial reduction in operating expenses is apparently made by the extensive use of the skip-stop system. When this system was introduced some years ago about 40 per cent. of the designated stops are said to have been eliminated, resulting in an increase of the average schedule speed from 9 to 11 miles per hour. This high speed is aided by traffic regulations which are enforced by the police.

In the following text, these various points are taken up and discussed in greater detail. Tables which contain statistics comparing Cleveland with four other large American cities are presented later. These cities are more or less comparable in size and general characteristics with Cleveland. All of these systems used for comparison are almost wholly confined in their operations to city and local-suburb service, and the statistics apply only to the single-fare areas. Three of the cities have a straight 5-ct. fare system, while the fourth has a 5-ct. cash fare, but also has a ticket system, giving a rate of approximately 4 cts. per ride. In these comparative statistics, the Cleveland report for the year 1914 is used, as this was most nearly comparable statistically with the data available for the other cities.

Brief History of 3-ct. Fare Situation in Cleveland.—In order to understand the present situation in Cleveland, it is necessary to know something of the events which led up to the formulation of the unusual city ordinance under which the Cleveland Railway is now operating in coöperation with the city. The story of the 10 years of bitter conflict between the city, as represented by Mayor Tom L. Johnson, and the railway interests is a remarkable one, which deserves the careful study of anyone interested in the relations of street railways with the public. It can only be briefly outlined in this paper.

Trouble between the public and the street railway companies in Cleveland had developed, even before Johnson's first election to the mayor's office in 1901, so that he was able to make a powerful campaign issue of the railway question. "Three-cent Fares" as a plank in any politician's platform was bound to be a popular one, and it must be remembered that Johnson, himself, before beginning his political career, had been in the street railway business in several cities, from the bottom to the top. Consequently, an intimate knowledge of the business gave him a great advantage over an ordinary type of political agitator. Although in the heat of conflict, and for the sake of political expediency, Mayor Johnson may have said and done things which at times seemed unfair and unreasonable, there can be little doubt that he was sincere in his belief that his ultimate object was right.

Public antagonism was aroused against the street railway companies because of the belief that they were making inordinate profits on watered stock, and were giving poor service in return.

Johnson believed in municipal ownership as the remedy for the real or fancied abuses of public-utility monopolies, but the laws of Ohio would not permit the city to own its street railways. In lieu of municipal ownership, Mayor Johnson resorted to another and even more deadly weapon, competition. He sought to interest promoters in constructing and operating new companies on streets where no prior tracks were laid, or on which the old companies' franchises were expiring, and after many unsuccessful and bitterly contested attempts, several 3-ct. fare companies were actually started and really began to threaten the business of the old company.[1]

The financial difficulties experienced by the Cleveland Electric Railway Co., as a result of public opposition, and the money spent in fighting and obstructing Mayor Johnson's tactics, resulted in the sacrifice of maintenance and improvements, so that the system was in pretty poor shape when a settlement was finally reached. Both sides, however, were so sure that their own way was the only right one, that attempts to compromise were futile. How absurd this situation was, is shown by the fact that at one time Mayor Johnson offered to agree to a settlement in which a holding company was to be organized to purchase the existing system on the basis of $85 per share of stock, which was approximately the then market price. The company refused to accept the plan, yet a few years later they were forced to reorganize on the basis of $55 per share. On the other hand, Mayor Johnson was so stubborn in his 3-ct. fare notions, that he refused to consider an offer of the company to establish a 7-for-25 ct. rate (3.57 cts. per ride) which the company agreed to put into effect on condition of a 25-year general franchise renewal.

In 1908, it seemed as if a settlement had been reached. As a result of the Goff-Johnson valuation, the Cleveland Electric Railway Co. was reorganized as the Cleveland Railway Co. and its capital stock arbitrarily cut down to meet the valuation figures, from $23,400,000 par value to $12,870,000 (from $100 per share to $55).[2] The Municipal Traction Co., a holding company sponsored by the Mayor and the City Council, leased the Cleveland Railway property on the basis of a guaranteed rental of 6 per cent. on the new stock. The lease went into effect in April, 1908, and 3-ct. fares were inaugurated by the Municipal Traction Co. with a public celebration and free riding for one whole day. In the next 6 months the Municipal Traction Co. met with

[1] In 1903, the two principal street railways in Cleveland united under the name of the larger one, the Cleveland Electric Railway Co.

[2] As to whether or not this valuation and stock reduction was fair to the stockholders, there may be doubt. See under heading "Investment or Value," p. 99.

enough difficulties and troubles to discourage a better-organized company, and at the end of that time a receivership was declared by Federal Judge R. W. Tayler, on failure to pay the guaranteed rental.

The adoption of the present so-called Tayler Ordinance ended the receivership on March 1, 1910. The scope of this research does not include a discussion of the merits and demerits of this peculiar franchise, and only certain features pertinent to this enquiry will be referred to. The capital figures used in this section and those entitled Investment or Value refer only to the old Cleveland Railway Co., and do not include the additional property brought in through the Forest City Railway Company by the Tayler Ordinance. The City Council and the Cleveland Railway Co. had united in inviting Judge Tayler to value the property and to help in bringing an end to the useless and disastrous series of controversies surrounding the transportation industry of the city.

Although Judge Tayler's valuation was somewhat different in its several items from the Goff-Johnson one, the final settlement required no further change in the basis of the Cleveland Railway capitalization. The most important and fundamental point of the Tayler Ordinance is that it provides for a sliding scale of fares, automatically regulated to provide a 6 per cent. dividend on the outstanding stock. On the old Cleveland Electric Railway stock the usual rate of dividends had been 4 per cent., and these were never sure, while under the new arrangement, 6 per cent. *on the reduced value stock* was practically guaranteed. As the old stock was selling on the market in 1901 for about $85, at 4 per cent. the holder's net return was about 4.7 per cent. of the market value with certain risks. Under the new arrangements, the owner of the same share gets 6 per cent. on $55 which is a net return of about 3.88 per cent. on the old market value, but he feels sure of it. The chart, Fig. 53, shows roughly the variations in market value, dividends, and the history of the stock from 1900 to 1914.

The Ordinance provides specific allowances for maintenance and other operating expenses, so as to prevent temptation of the company to make willful over-expenditures for the purpose of increasing fares. These allowances may be raised or lowered by mutual agreement between the City Council and the company, or by arbitration. The company has always claimed that the ordinance allowances are too small and the actual expenditures have been in excess of the allowances. Control of service is vested in the City Council. A City Street Railway Commissioner subordinate to the Council and the Mayor, really supervises the whole operation and financing of the Cleveland Railway Co., which is, nevertheless, a strictly private monopoly under municipal supervision.

The Tayler Ordinance was amended in 1911. The chief adjustment was in the terms of the Ordinance giving the city the right to purchase the property. The original provision had been to allow the city to purchase at a price equal to the value of

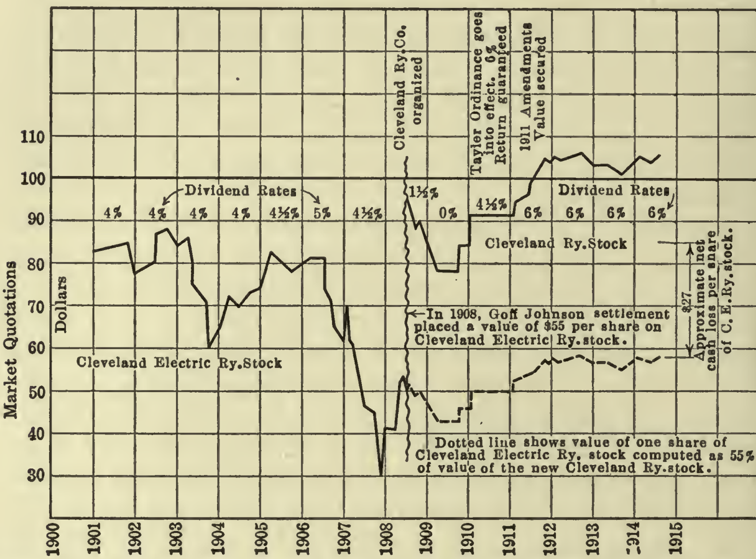

FIG. 53.—Variations in market value of stocks of Cleveland Electric Railway Co. and Cleveland Railway Co.

the property plus 10 per cent., except at the end of the grant when the 10 per cent. is not to be added. As the Ordinance also stipulated that all property should be maintained at 70 per cent. condition, it appeared as if investment in new property would immediately be depreciated 30 per cent. without any way of making good this loss to new investors. Consequently, it was found to be impossible to sell new stock for improvements and additions. The amendment of 1911 provided that in case of purchase by the city, the price should be equal to the par value of all outstanding stock issued in accordance with the provisions of the Ordinance plus 10 per cent., and any legitimate bonded debt should be assumed by the purchaser, or paid off if expedient. The effect of this amendment was to secure the par value of the stock against any future losses due to depreciation of plant. The franchise expires in 1934 with no obligation for the city to purchase the property or renew the franchise, but the company has the privilege of using the highest rate of fare during the last 15 years, and if a franchise is granted to others to operate over these lines then they must purchase at the conditions provided for the city.

One of the results of the years of conflict was that the original stockholders in the old Cleveland Electric Railway lost $45 per share on the par value of their stock, but the real loss was considerably less, as the old stock sold below par on the market, while the new stock has been worth more than par since 1911. The chart, Fig. 53, shows the variation in market quotations of the stock since 1900, dividends paid and important dates. Taking $85 as approximately the fair market value of the stock about 1901–02; and $105 as the present market[1] value of the new stock, the net cash loss to the stockholder may be figured as $27.25 per share ($85 down to $55 equals $30 loss, less 55/100 of present $5 premium equals $27.25).

The car riders of Cleveland suffered years of bad service, and the lack of needed extensions and modern improvements. Today their average fare with transfer charges (3.43 cts.) is nearly as high as that offered by the company (7 for 25 cts.) years before the final settlement. Both sides, could they have foreseen the outcome, might have avoided the greater part of these losses by getting together on some reasonable compromise, early in the conflict.

Rates of Fare in Cleveland—The "Interest Fund."—The sliding scale of fares provided for in the Ordinance is designed to automatically keep the receipts balanced with the "allowed" expenses. A so-called "interest fund" with a normal balance of $500,000 acts as a barometer. All income over the stipulated operating and maintenance allowances goes into the interest fund, and from it is deducted the money for taxes, interest and 6 per cent. dividends. A variation of more than $200,000 either way from the normal $500,000 balance, causes the rate of fare to be raised or lowered one point on the sliding scale.

There are ten different fare schedules in the sliding scale, or actually five different combinations with and without the 1-ct. transfer charge. The principle was adopted of always charging 1 ct. cash for transfers, and under five of the different fare schedules this charge is rebated to the passenger on the legiti-

[1] Date of investigation, spring of 1916.

mate presentation of the transfer for passage on the transfer line. The schedule is worthy of note and is abstracted from Section 22 of the Ordinance as follows:

(*a*) 4-ct. cash fare,	7 tickets for 25 cts.,	1 ct. transfer,	no rebate
(*b*) 4-ct. cash fare,	7 tickets for 25 cts.,	1 ct. transfer,	1 ct. rebate
(*c*) 4-ct. cash fare,	3 tickets for 10 cts.,	1 ct. transfer,	no rebate
(*d*) 4-ct. cash fare,	3 tickets for 10 cts.,	1 ct. transfer,	1 ct. rebate
(*e*) 3-ct. cash fare *	....	1 ct. transfer,	no rebate
(*f*) 3-ct. cash fare *	....	1 ct. transfer,	1 ct. rebate
(*g*) 3-ct. cash fare,	2 tickets for 5 cts.,	1 ct. transfer,	no rebate
(*h*) 3-ct. cash fare,	2 tickets for 5 cts.,	1 ct. transfer,	1 ct. rebate
(*i*) 2-ct. cash fare	....	1 ct. transfer,	no rebate
(*j*) 2-ct. cash fare	....	1 ct. transfer,	1 ct. rebate

The practice of handling a penny for transfers in any case is intended chiefly to minimize the abuse and unnecessary use of transfers. The above schedules may strike one as forming a rather cumbersome and perhaps illogically arranged combination. It may well be that a simple and more direct set of schedules could be devised to accomplish the desired result. It would seem that if a transfer charge of 1 ct. is justifiable at all, it should be a permanent institution and the cash and ticket fares arranged to make up the sliding scale.

When the Tayler Ordinance went into effect March 10, 1910, schedule (*e*) was adopted, namely the 3-ct. cash fare, 1-ct. transfer charge, no rebate. The average fare for the 10 months of 1910, under this schedule, was 3.39 cts. The fare was dropped June 1, 1911, after 15 months, to schedule (*f*), *i.e.* the 1-ct. transfer charge was thereafter rebated. Peculiar circumstances surrounded this reduction in rate of fare, as a result of the iron-clad provisions of the Ordinance. The interest fund showed an apparent excess of over $200,000 above the normal of $500,000, but it was based on accounts kept in accordance with the Ordinance allowances for operating and maintenance. The company had actually spent more money for operating expenses and maintenance than the allowed amounts. Part of this over-expenditure was due to the setting up of an accident reserve which was later deemed excessive by a board of arbitration, but much of the over-expense was due to apparently proper necessities. However, in accordance with the Ordinance, fares had to be reduced in the face of an actual deficit.

* As a matter of expediency in operating, tickets have been sold under this schedule at 5 for 15 cts. This avoids the necessity for making penny change and does not violate the intent of the Ordinance.

Thirty-eight months of 3-ct. fares with the 1-ct. transfer charge rebated, ensued. On Sept. 1, 1914, the company was again authorized to restore schedule (*e*), in other words, to retain the 1-ct. transfer charge, as the interest fund had fallen below $300,000. At the time of writing this paper, schedule (*e*) is still in effect. Special heavy allowances for writing off obsolete equipment make it unlikely that the lower rate will be resumed for some time, especially in view of the fact that the actual deficit in 1914 was the largest since 1910 (see statistics, Table V).

The effect of the non-rebate of the 1-ct. transfer charge is to make a 3-ct. fare for some passengers and a 4-ct. fare for others, without any particular regard to the total distance either may travel, and it will increase the average fare about 0.4 ct., as there is a normal ratio of transfer to revenue passengers of nearly 40 per cent.[1]

The average fare is always kept slightly over 3 cts. by the rule of the company, sanctioned by the city, that passengers shall present the correct 3 cts. change or a 3-ct. ticket (sold at 5 for 15 cts. by all conductors) or else pay a 5-ct. fare. Conductors will not make penny change for fares, but they do for transfers. Where a passenger demands a 1-ct. transfer and presents a coin sufficient for payment of fare and transfer, and does not buy tickets, he is given nickel and silver change and is obliged to put the nickel fare in the fare box, before the conductor gives him his penny change for the transfer, thus his fare becomes 6 cts., if the passenger deals with the matter in this way in preference to buying the tickets sold in default of 3 pennies being tendered for fare.

Certain distant suburbs do not get the 3-ct. fare service, but are charged 2 cts. more. In other words, a 5-ct. fare applies to service to and from these suburbs, instead of the 3-ct. fare of of the rest of Cleveland's district.

The map, Fig. 36, shows clearly the extent of the 3-ct. and 5-ct. fare territories.

Another factor tending to keep the average fare over 3 cts. is found in the practice of charging 5-ct. fares for all passengers riding on interurban cars in or out of Cleveland, over the Cleveland Railway tracks.

It is stated that about 90 to 95 per cent. of all fares in Cleveland are paid with 3-ct. tickets and nearly 40 per cent. of the riders use 1 ct. transfers in addition.

[1] *I.e.* nearly 40 per cent. of all revenue passengers use transfers.

The average fare per revenue passenger, including all the above-mentioned factors for the past five years, has been as follows:

1910......3.39 cts. (1-ct. transfers, no rebate)
1911......3.34 cts. (1-ct. transfers, 1-ct. rebate after June 1, 1911)
1912......3.18 cts. (1-ct. transfer, 1-ct. rebate)
1913......3.17 cts. (1-ct. transfer, 1-ct. rebate)
1914......3.25 cts. (1-ct. transfer, no rebate after Sept. 1, 1914)
1915......3.43 cts. (1-ct. transfer, no rebate)

The 1-ct. Fare Line.—There was in operation, during the summer months of 1915, a short connecting line between the Public Square and the East 9th St. docks, on which a 1-ct. fare was charged with no transfers to or from other lines. The opening of this line was "written up" in some newspapers in other cities and in certain periodicals, and praised as the ultimate triumph of municipal control over corporations. A universal 1-ct. street-car fare was heralded as a proved success. As a matter of fact, apparently nobody in Cleveland, whether connected with the city or the company, had any such idea. The line was put into operation by the Street Railway Commissioner on this basis only to avoid the multiplicity of 1-ct. transfers which would be necessary if the regular fare were collected on this line. It was about ¾ mile in length and as a general rule, averaged receipts of better than 20 cts. per car-mile. It operated only during the summer season while the Lake steamers and excursion boats were running. It was found that, in addition to the transfer riders, the possibility of riding for 1 ct. attracted quite a few short riders who used it as a matter of convenience, whereas they would have walked the short distance between the docks and the Public Square, had the fare been 3 or 5 cts.

High Traffic Density.—The one factor of greatest influence in making possible a low fare in Cleveland, is the high density of traffic as shown by the transportation of 740,000 revenue passengers per mile of single main track operated, and 6.86 revenue passengers per car-mile in the year 1914. A comparison of these figures with statistics of the other cities listed in Table VI, shows Cleveland to be well ahead in density of traffic.

The riding habit in Cleveland is fairly high. According to the Federal Census of 1910, Cleveland had a population of 560,663, and during the same year, 171,753,896 revenue passengers were carried, a riding habit of 306 per capita, which is high for a city of Cleveland's size. The lines and population served outside Cleveland's city limits are small, and a more accurate figure of population would only slightly reduce the above result.

While the low fare itself is, no doubt, partially responsible for the high density of traffic, the general configuration of Cleveland, its comparative prosperity, and the absence of effective competition by steam railroads and jitneys for local traffic, must also be considered.

Reference will be made later to the relation of total cost of service to density of traffic, as discussed and illustrated in Chapter II.

The rapid growth of passenger traffic since 1910 is shown by the chart, Fig. 47.

Short Riding.—Frequent and rapid service, combined with the low rate of fare, is naturally conducive to short riding. It is quite noticeable that passengers board the cars for rides of only a few blocks, even out in the suburbs toward the ends of lines, where the load on the car is naturally light. Needless to say, this is a highly desirable condition from the point of view of the street railway operator.

Quality of Service.—It has been claimed that the Cleveland authorities have succeeded in establishing and continuing the low fares only by means of greatly overcrowding the cars. It is probably true that this condition of overcrowding existed during the short life of the ill-fated Municipal Traction Co. experiment. Overcrowding must have also existed during the earlier period of the operation of the present Tayler Ordinance, while the density of traffic was being built up, and the system rehabilitated.[1] No system can operate under present conditions in a large city at much less than 17 to 18 cts. per car-mile, whether the cars be large or small. Consequently, when fares are cut, more people must be carried per car-mile to keep up the earnings. Recognizing this fact, the Cleveland authorities at once set to work to replace the old, low-capacity rolling stock with new and larger cars. Today they have only a few small cars in operation, and these are relegated to the short and less important routes. This has reduced crowding to dimensions comparable with conditions in other cities where the service is considered fairly good.

On Jan. 1, 1915, the Cleveland Railway Co. had on hand the following passenger cars:

[1] In 1913, there occurred the highest number of passengers per car-mile. See Table V.

74 40-seat cars	1 54-seat trailer-car
198 42-seat cars	1 55-seat trailer-car
66 43-seat cars	27 56-seat cars
193 45-seat cars	165 58-seat cars
188 46-seat cars	300 59-seat trailer-cars
153 53-seat cars	

Present plans call for a still further reduction in the number of small cars, and their replacement with large ones. In addition to the greater seating capacity, the new cars in Cleveland are designed with large platforms and wide center aisles, so that even in case of a large percentage of standing passengers, the crowding does not become uncomfortable or objectionable. No open cars are operated. By the use of the large 59-seat trailers, rush-hour peak loads are handled with only one additional man per trailer, whereas a crew of two men is needed on individual motor-cars. This effects a considerable saving in operating expenses.

It would require more time and expense than can be expended in this research to make a complete survey of traffic and service in Cleveland. The results, however, of a visit to Cleveland in the fall of 1915, and such observations of the operation of the street railway system as opportunity has afforded, lead to the opinion that the service in Cleveland is about as good as in the majority of cities where a higher fare is charged. An observer standing during the rush hours at points just outside the business district on certain important lines, usually sees very few cases of really crowded cars. The table (Table VII) summarizes briefly some data taken during afternoon rush hours, of the number of cars on different lines—with vacant seats, with seats just filled, with from 1 to 10, 11 to 25, and over 25 standing.

Former Street Railway Commissioner Peter Witt claimed that he could eliminate almost all standing, if the public would be a little more reasonable about boarding already crowded cars, and if the cars could be got over the tracks without the many incidental delays which so generally play havoc with the best of schedules in congested city streets. Of course, these particular conditions are by no means peculiar to Cleveland. Nearly every city system experiences the same difficulties. As a matter of fact, Cleveland possesses a well laid out system of wide, straight streets which are favorable to efficient street railway operation at high speed, and the effective police regulation of independent vehicles is an aid.

The present quality and quantity of service may possibly fall short of the rather high standard set by the Railroad Commission of Wisconsin, but it will certainly appeal to the average man of general acquaintance with traffic conditions as being on the whole about as satisfactory as in the majority of cities.

There are certain things about the service which may be criticised, such as the tendency to overdo the high-speed plan and the consequent temptation to the car crews to start the cars too quickly. The skip-stop system, in operation all over the city, is praised by some and condemned by others. The rather confusing methods of fare collection, discussed below, are a source of some adverse criticism.

Methods of Fare Collection.—The lack of uniformity in methods of fare collection is distinctly noticeable, and results in some annoyance and confusion, not only to the stranger, but to the regular car-riders in Cleveland. On radial lines, the pay-enter system is used on inbound trips, and the pay-leave system on outbound trips, to avoid delays in loading or unloading passengers. The system is further complicated, however, by the use of new center-entrance cars, on which the rule is pay-enter if one goes into the front half of the car, and pay-leave if he uses the rear half. If he stays in about the middle, he is not quite sure which to do.

The policy of refusing to make penny change for 3-ct. fares is undoubtedly a wise one, for great loss of time would result if conductors had to do this. The people have become used to this phase of the situation, and they now use the strip tickets (5 for 15 cts.) almost exclusively. It is only the transient stranger who contributes the few nickel fares which are collected. The 1-ct. transfer system requires considerable work on the part of the conductors, who, in this case, are obliged to make correct change. This change, however, under the rules, is not tendered to the passenger until after he has deposited his ticket, 3 pennies, or a 5-ct. piece in the fare box.

Receipts and Expenses per Revenue Passenger.—There is no mystery connected with the operation of the Cleveland street car lines at rates of fare averaging a little over 3.3 cts. The company's accounts are kept in an apparently straightforward manner, the operating expenses being compiled in accordance with a standard classification. The expenses of the City Street Railway Commission are charged to operating expenses, as they should be. Taxes have been approximately 6 per cent. of gross revenue and are properly debited in the annual reports. The company, however, with the assistance of the city, is fighting the payment of the State tax levies. The paving requirements met by the company are less onerous in Cleveland than in some cities but not materially different from those in other cities.

The allowance specified by the Tayler Ordinance for maintenance, depreciation and renewals is made up of 4 cts. per car-mile for 6 months, 5 cts. per car-mile for 1 month, and 6 cts. per car-mile for the other 5 months of each year. The car-miles are those actually run by all motor-cars, plus 60 per cent. of those actually run by trailer-cars in revenue-collecting service. Yard and car-house mileage is not included. Similarly, 11½ cts. per car-mile is the specific ordinance allowance for operating expenses other than the foregoing.

These allowances proved to be inadequate, and the company actually spent more than the allowances. In 1913, after arbitration proceedings, an increase in operating allowance from 11.5 to 12.1 cts. per car-mile was made,[1] and provisions were made for partially making the previous overdrafts good from the rather large accident reserve which had been set up by the company. The remaining overdraft is now being taken care of by special deductions from gross receipts, fare schedule (*e*) being now in use since September, 1914.

In the accompanying statistical analyses, *actual car-miles* have been used of both motor- and trailer-cars instead of the 60 per cent. basis for trailers, so that these statistics on operating expenses and maintenance will not check the figures given in the Cleveland Railway Co. reports, but will be somewhat lower. This seems to be the only convenient way of comparing the expenses and traffic with those of other street railways.

In view of the fact that the operating allowance was increased, and prior overdrafts provided for, the company's figures of actual expenditures rather than the Ordinance allowances have been used in these analyses. It is shown in the table (Table V) just what the deficit per revenue passenger has been each year under these conditions. It will be noticed that even if the average fare were raised to just cover these deficits each year, it would still be only about 3½ cts. per revenue passenger.

For the year 1915, the average receipts and expenses *per revenue passenger* were:

[1] This has since been increased to 12.6 cts. per car-mile.

Average gross revenue from all sources, cts. per r.p..		3.55
Average operating expenses, including maintenance and depreciation, cts. per r.p.	2.49	
Average taxes, cts. per r.p.	0.20	
Average interest and dividends, cts. per r.p.	0.77	
Average total expenses, cts. per r.p.		3.49
Average surplus, cts. per r.p.		0.09

If the tax litigation is won, the accumulated deficit of past years will be partially offset. This shows plainly the fact that taxes on public service corporations are taxes on the patrons—which many people still forget.

To demonstrate how these figures compare with the receipts and expenses per revenue passenger on other street railway systems, the table (Table VI) has been prepared. It is also to be observed by comparing the Cleveland column with Table III that the average operating expense in Massachusetts is over a cent per revenue passenger greater than in Cleveland. Local conditions in Cleveland account for at least a large part of this difference, and traffic density is responsible for no small part of the whole.

Car-mile Expenses are Normal.—Cleveland cannot operate cars at a lower cost than other cities merely by virtue of an unusual ordinance. As a matter of actual fact, the total operating expenses including renewals and replacements, per revenue car-mile, are fairly comparable with the corresponding figures of other systems. These statistics are shown in some detail in Table VI. The wages of motormen and conductors are as high, if not higher, in Cleveland than elsewhere. Wages of 30 cts. per hour is the standard rate for first-year men, and 32 cts. per hour thereafter. The rate per car-mile is kept down materially by two factors, namely, high schedule speed, and trailer-car operation requiring only one additional man per trailer. Maintenance and depreciation charges in Cleveland's 1914 accounts were higher per car-mile than for the other four cities compared (see below, "*Maintenance and Depreciation*").

With operating expenses per car-mile about on a par with those in the other cities, the primary reason for the lower cost per revenue passenger comes from the larger number of passengers carried per car-mile.

Maintenance and Depreciation.—It has frequently been charged that one result of low fares in Cleveland is insufficient provision for repairs and no provision for future renewals and replacements. Inasmuch as there is no fund on hand for a depreciation reserve and there is still a deficit in the maintenance fund, there is some justification for this charge. However, it must be remembered that the Tayler Ordinance established a value, based to some extent on the then greatly depreciated condition of physical property. Since the settlement in 1910, very large sums have been spent each year in renewing and rehabilitating the property. A great many miles of track have been completely renewed, much old rolling stock has been scrapped or sold, and new equipment purchased. They are now somewhat behind in charging off the cost of superseded or discarded equipment, but a special allowance is gradually wiping it out. The transfer charge of schedule (*e*) was adopted Sept. 1, 1914, to help in making good this deficit.

The policy in regard to replacements is to write off the cost-new of old property, although the Tayler Ordinance put a depreciated value on it in the settlement.

The present condition of track and rolling stock appears to be very good. Commissioner Witt claimed that as soon as the extraordinary rehabilitation work is completed, the present Ordinance allowances for maintenance will be excessive. On the other hand, some street railway men claim that even now the property is depreciating faster than the money is being put back into it in maintenance. It is almost impossible to see how the truth of these opposing claims can be definitely settled until time has shown the ultimate result.

Some light is thrown upon this subject, however, by comparing Cleveland's present expenses for repairs and renewals with the corresponding figures of the other four cities used for comparison. In 1914, the amount provided per mile of track and per car-mile operated, for repairs and renewals, was actually considerably higher in Cleveland than in any of the other four comparative cities. Even when the relative intensity of the use of track and equipment is considered, Cleveland still compares favorably. In Table VI, the repairs and renewals expenses, and comparative use of track, have been analyzed for each of these systems. Table V shows that in Cleveland these unit expenses for repairs and renewals were not so large in the earlier years as in 1914, so that the 1914 figures used for comparison really show Cleveland at a little better than its average.

Taxes.—Taxes (as charged, but not all actually paid, pending litigation) are somewhat lower per revenue passenger in Cleveland than in the other four cities. The 1915 tax charge in

Cleveland was approximately 6 per cent. of gross revenue and about 1.6 per cent. of the book value of the property.

Interest and Dividends.—The amount paid out for interest and dividends varied between 0.7 and 0.8 ct. per revenue passenger during the years 1911 to 1915. In 1914 it was 0.74 ct. per revenue passenger. This is about the lowest figure found on any paying street railway system. Some comparative figures are shown in Table VI.

Naturally the high traffic density, which helps to keep the other expenses low per revenue passenger, also tends to reduce the item of interest and dividends as a part of the cost for each passenger. The average rate of return of nearly 6 per cent. is lower in Cleveland than in most other cases of prosperous street railways, but the rate of return is substantially insured to the investors by the sliding-rate schedule in Cleveland.

Investment or Value.—As previously explained in the discussion of the history of Cleveland's 3-ct. fare situation, the capital stock was arbitrarily cut down from a total of $23,400,000 to $12,870,000 (from $100 to $55 par value per share), but the actual loss in market value to the stockholders has been about $27.25 per share or 32 per cent. of the then market value.

It is difficult to determine at this late date, whether the valuation which resulted in this reduction of capital stock was fair or not to the then stockholders. No information can now be obtained concerning the actual original cash investment in the Cleveland Electric Railway Co., and the older companies which were merged with it. As it has been the pretty general practice in this country, in the early days of street railroading, to issue larger amounts of stock than were actually paid for by investors, it is not unlikely that the $23,400,000 capital stock of the Cleveland Electric Railway Co. was partially inflation.

About the only criterion which we can apply today with any degree of safety is the test of total investment, or value, per revenue passenger, making due allowance for the effect of density of traffic. This may be done on the chart, Fig. 3, where the Cleveland investment is 13.3 cts. per revenue passenger, at 6.87 revenue passengers per car-mile. It falls low down, but within the curves which were drawn in to represent the "ordinary" range of investment per revenue passenger.

As matters stand today, the difference due to the cutting down of the value of the old stock makes only a trifling difference in the fares. If we assume that the actual loss to the old stockholders was $27 per share on 234,000 shares, and then assume that this loss of 234,000 × $27, or $6,318,000, was to be put back into the present capitalization, the addition to dividend requirements at 6 per cent. would only impose an added charge of 0.16 ct. on each revenue passenger on the basis of the 230,000,000 carried in 1914. On the basis of the 171,000,000 carried in 1910, the added charge would have been 0.22 ct. per revenue passenger. Even in 1908, when the reduction was made, 0.25 ct. on each fare would have paid 6 per cent. on the amount representing this loss in value.

Summary.—The foregoing text and accompanying statistics show that the Cleveland Railway Co., under the Tayler Ordinance and consequent supervision of the city, is giving fairly good service at a cost per car-mile approximately comparable with that in other cities, and because of a high density of traffic, because of a rather limited but substantially insured return on the agreed capitalization, and with slight deficits not yet fully taken care of, it is giving this service to the public at an average rate of fare under 3½ cts. per fare collected. It is also evident that the Cleveland system is running on nearly the minimum of each class of expenses discussed and illustrated in Chapter II.

The characteristics of the sliding scale of fares, rather offsets criticism that is sometimes raised because no surplus or reserve is accumulated for extraordinary depreciation or the proverbial electric railway's "rainy day." If, in the course of time, it is found that depreciation is getting ahead of repairs and renewals, or that prior deficits are not wiped out, the rate of fare may be raised a step at a time, without undue hardship on anyone until the situation is fully taken care of. Similarly, if some unusual contingency depletes the income of the company, a slight increase of the fare rate will, in the ordinary course of events, gradually offset this contingency. *In this respect, the Cleveland situation is unique and possesses a considerable advantage over other street railways which are tied by long-standing custom to an inflexible unit fare* which cannot be raised without almost insurmountable opposition by the public, and cannot be lowered because the whole theory of street railway financiers and operators in this country is adverse to lower rates of fare.

There are certain features of detail about the Ordinance, the arrangement of the sliding scale of fares, the guaranteed but

TABLE V.—CLEVELAND RAILWAY CO.—*Under Tayler Ordinance*

	Year ending Dec. 31					
	1910(*c*)	1911	1912	1913	1914	1915
Passenger receipts	....	$6,310,525	$6,452,865	$6,966,129	$7,482,506	$8,255,642
Total revenue, including misc. income	$5,196,472	6,423,209	6,679,772	7,190,767	7,735,677	8,542,313
Operating expenses, actual	3,876,276	4,895,969	4,935,574	5,479,657	(*b*)5,999,675	(*b*)5,991,714
Taxes	310,598	370,455	366,591	435,521	466,996	488,064
Interest and dividends	1,128,023	1,441,170	1,416,542	1,574,008	1,702,260	1,856,501
Deficit	118,435	284,385	38,935	298,419	433,254	(*d*)206,034
No. of revenue passengers	....	189,244,894	203,349,655	220,511,190	230,149,207	240,386,539
No. of revenue and transfer passengers	....	257,598,412	282,985,088	308,107,618	322,801,666	330,869,534
No. of passenger car-miles, actual	....	27,924,866	29,049,000	30,908,289	33,514,050	33,919,603
Miles of single main track operated	....	....	280	298	311	329
Total capital, stock, bonds, etc	$24,091,600	25,074,600	$25,074,600	$26,906,800	$30,744,155	$32,295,060
Av. fare, cts. per revenue passenger	3.39	3.34	3.18	3.17	3.25	3.43
Av. total revenue, cts. per revenue passenger	....	3.40	3.29	3.27	3.36	3.55
Av. operating expense, cts. per revenue passenger	....	2.58	2.43	2.49	2.61(*b*)	2.49(*b*)
Av. taxes, cts. per revenue passenger	....	0.20	0.18	0.20	0.20	0.20
Av. interest and dividends, cts. per revenue passenger	....	0.76	0.70	0.72	0.74	0.77
Av. deficit, cts. per revenue passenger	....	0.15	0.02	0.14	0.19	(*d*)0.09
Av. total capitalization, cts. per revenue passenger	....	....	12.3	12.2	13.3	13.3
Av. revenue passengers per car-mile	....	6.80	6.99	7.13	6.87	7.10
Av. total passengers per car-mile	....	9.23	9.74	9.95	9.88	9.76
Av. revenue passengers per mile of single main track	....	....	725,000	740,000	740,000	730,000
Maintenance expenses	....	$1,506,652	$1,387,427	$1,775,373	$2,048,438(*b*)	$1,916,712
Maint. expense per mile of single main track	....	....	$4,950	$5,950	$6,590	$5,820
Maint. expense per car-mile, cts. (*a*)	....	5.35	4.74	5.71	6.08	5.61

(*a*) Revenue car-miles (total) used, instead of passenger car-miles.
(*b*) Includes special depreciation allowance.
(*c*) Ten months of Cleveland Ry. Co.
(*d*) Surplus for year 1915. Deficit for 1913–15 inclusive is $525,639.

Table VI.—Cleveland—Comparative Traffic Density and Operating Expenses

	Cleveland Railway Co., 1914	Company I	Company II	Company III	Company IV
Opt. exp. (excl. maint.) cts. per car-mile (*a*)	11.71	12.60	13.40	13.05	12.95
Total opt. exp. (incl. maint. and depr.), cts. per car-mile	17.78	17.19	19.40	18.98	17.86
Opt. exp. (excl. maint.), cts. per rev. pass	1.72	2.21	2.18	2.05	1.98
Total opt. exp. (incl. maint. and depr.), cts. per rev. pass	2.61	3.02	3.16	2.98	2.73
Surplus or deficit., cts. per rev. pass	−0.19	+0.76	+0.23	−0.31	
Rev. passengers per mile of single main track	740,000	672,000	454,000	528,000	651,000
Rev. passengers per passenger car-mile	6.86	5.69	6.13	6.36	6.56
Total passengers per passenger car-mile	9.63	9.66	8.35	8.95	8.55
Av. fare, cts. per rev. pass	3.25	4.98	5.00	4.19	4.97
Gross revenue, cts. per rev. pass	3.36	5.10	5.04	4.25	5.04
Opt. exp. and depr., cts. per rev. pass	2.61	3.02	3.16	2.98	2.73
Taxes, cts. per rev. pass	0.20	0.21	0.32	0.33	0.35
Other charges on income, cts. per rev. pass	....	0.01	....	0.01	
Interest and dividends, cts. per rev. pass	0.74	1.10	1.33	1.24	(*b*)
Total expenses, cts. per rev. pass	3.55	4.34	4.81	4.56	(*b*)
Surplus or deficit, cts. per rev. pass	−0.19	+0.76	+0.23	−0.31	(*b*)
Maint. and depr. per mile of single main track	$6,590(*e*)	$5,420	$4,440	$4,880	$4,870
Maint. and depr. cts., per rev. car-mile	6.08(*e*)	4.60	6.00	5.96	4.90
Car-miles per mile of single main track	108,300	118,000	74,000	82,000	99,500
Comparative per cent. use of track (*c*)	100	109	68	76	92
Comparative per cent. maint. and depr. per mile of single main track (*d*)	100	82	68	74	74
Maint. and depr. expenses, cts. per car-mile	6.08	4.60	6.00	5.96	4.90
Traffic expenses, cts., per car-mile	0.00	0.01	0.16	0.01	0.00
Motormen and conductors wages, cts. per car-mile	5.96	6.74	6.30	6.14	5.94
Power expenses, cts., per car-mile	2.16(*f*)	2.67(*f*)	2.14	2.24(*f*)	2.42
Other transportation expenses, cts. per car-mile	1.17	1.09	2.10	1.63	1.85
Injuries and damages expenses, cts. per car-mile	1.21	1.21	{ 2.70	1.28	1.50
Other general expenses, cts. per car-mile	1.20	0.87		1.72	1.25
Total operating expenses, cts. per car-mile	17.78	17.19	19.40	18.98	17.86

(*a*) Actual mileage, trailers counted 100 per cent.
(*b*) Amount paid as interest and dividends not known.
(*c*) *i.e.*, ratio "car-miles per mile of single main track" of other cities to Cleveland.
(*d*) *i.e.*, ratio "maintenance and depreciation charges per mile of single main track" of other cities to Cleveland.
(*e*) Company's actual maintenance expenditures.
(*f*) Where power is purchased from a separate company, maintenance and interest charges are included.

limited rate of return, and the methods of operating, which may be deserving of fuller discussion, but which do not come within the scope of this paper. The statistics lead to the direct conclusion that density of traffic, reduced number of car stops, and relatively short hauls put Cleveland in its position of legitimately obtaining 3½-ct. fares. This is aided by the partial guaranteeing of a rate of return by the city by means of a sliding fare scale, by street traffic regulations and certain other features not utilized in most cities.

The former Street Railway Commissioner of Cleveland expressed his belief that in a comparatively short time the system can go back to the lower schedule of fares, *i.e.*, 3 cts., the transfer charge being rebated. The statistics and history of expenses since 1910 given in Table V do not seem to warrant this opinion.

TABLE VII.—CLEVELAND—OBSERVATIONS OF SERVICE

Outbound Cars—Evening Rush, 5:00 P.M.–6:15 P.M.—Passing Cor. Broadway & Woodland Ave.—Thursday, Sept. 16, 1915

Line →	Broadway	Woodland	Kinsman	Union
No. of cars passing with 1 or more vacant seats	8	5	0	0
No. of cars passing with seats just filled	4	4	1	2
No. of cars passing with 1 to 10 standing passengers	13	10	4	4
No. of cars passing with 11 to 25 standing passengers	17	20	14	6
No. of cars passing with more than 25 standing passengers	5	13	1	4
Total cars passing in 1 hr. and 15 min	47	52	20	16

Outbound Cars—Evening Rush, 4:45 P.M.–5:55 P.M.—Passing Cor. Euclid Ave. & E 14th St.—Friday, Sept. 17, 1915

Line →	E. Cleveland	Scovill	Collinwood	Euclid to 140th & Euclid Village
No. of cars passing with 1 or more vacant seats	9	13	1	2
No. of cars passing with seats just filled	2	5	1	0
No. of cars passing with 1 to 10 standing passengers	5	9	2	3
No. of cars passing with 11 to 25 standing passengers	8	7	4	7
No. of cars passing with more than 25 standing passengers	7	1	0	1
Total cars passing in 1 hr. and 10 min	31	35	8	13

CHAPTER VIII

A STUDY OF THE ZONE SYSTEM IN MILWAUKEE

By an order dated Jan. 2, 1914, the Railroad Commission of Wisconsin formally approved the first important attempt in this country to revise ordinary street railway fares on a zone or distance basis. This revision of fares and zones was confined almost wholly to the suburban district outside of the city proper. *The city fare was not changed by this order and only one change of importance in the fare limits of the city area was made.*

As the question of a zone or distance rate of fare is very pertinent to the work of this research, considerable attention has been devoted to analyzing the Milwaukee situation.[1] The object of this analysis is to show how the changes were made from irregular and unequal suburban 5-ct. zones to nearly uniform zones of approximately a mile each at a 2-ct. zone rate, later modified by a ticket rate of 1⅔ cts. per zone. It is also proposed to compare the passenger traffic, earnings and average fare on these suburban lines before and after the change to the mile-zone system.

The old fare system entailed a 5-ct. fare, 6 tickets for 25 cts. or 25 for $1, within the one-fare area of the City of Milwaukee, which corresponded approximately to the city limits. Suburban extensions beyond these one-fare limits were divided into one or two additional 5-ct. zones. The latter were of various lengths and some apparently unjustifiable extremes may be noted, as, for instance, a 5-ct. zone of only 1.4 miles on the Wanderers Rest line and a 5-ct. zone of 7.2 miles on the South Milwaukee line. In the instances cited, some of the differences in length of 5-ct. zones were perhaps partially justified on account of the

[1] The details of this zone system, and some data on the analysis of cost of service were contained in a paper entitled "A Zone System of Fares in Practice" by Mr. R. B. Stearns, Vice President of the Milwaukee Electric Railway and Light Co., at the annual convention of the American Electric Railway Association, October, 1914. We are indebted to Mr. Stearns for data contained in his paper and for much additional information which he has furnished.

much greater volume of travel on the South Milwaukee line. In general, however, the 5-ct. zones varied in length from 2 to 4 miles. The effect of the order of Jan. 2, 1914, was to split these 5-ct. zones of varying lengths into from one to seven zones, depending upon the length of the line, each zone being about 1 mile in length. On the Cudahy-South Milwaukee line the Milwaukee city-fare limit was drawn in 0.78 miles, thus imposing

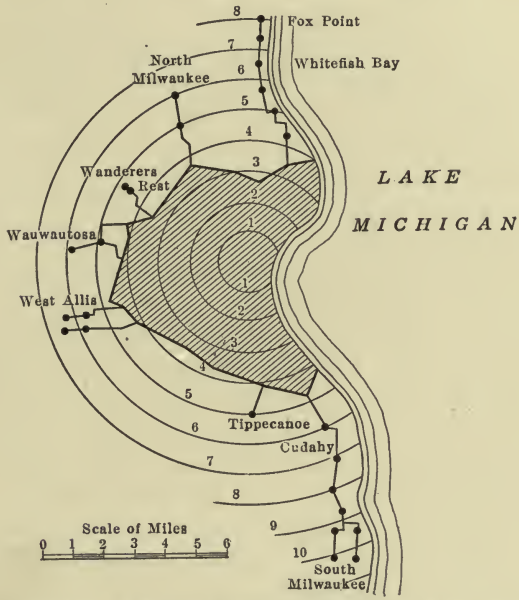

FIG. 54.—Milwaukee, Wis., single-fare limits under zone system in 1915. Population (1910) 373,857.

Rates of fare of the Milwaukee Electric Railway and Light Co.[1] In shaded area: 5¢ cash {25 tickets for $1.00 (4¢ per ride / 6 tickets for 0.25 (4⅙¢ per ride} free transfers. Outside of shaded area: 2¢ cash per zone (30 tickets for 50¢, 1⅔ cts. per zone). Limits shown by dot. Single-fare area 33 square miles. Average single-fare radius 3.6 miles.

one additional zone. This zone was subsequently eliminated by replacing the city-fare limit at its original position in accordance with the order of Oct. 28, 1914. The Tippecanoe line, originally all within the city-fare limit, had one zone, a mile long, imposed on the outer end, thus shortening the length of ride possible for the city fare on that line. The map of Milwaukee, Fig. 54, shows the present scheme of fares and fare zones.

[1] This company operates the whole Milwaukee system, but some of the lines are owned by the Milwaukee Light, Heat, and Traction Co.

The rate of fare for these new suburban zones was first set at 2 cts. by the Commission's order of Jan. 2, 1914. This rate was determined by a cost basis estimate and modified in an attempt to take into account the effect of rate of fare on the amount of traffic. The report stated that a cost analysis showed that a rate of 2.75 cts. per mile would be necessary, with the existing traffic, to pay a return of 7½ per cent. upon the cost of reproduction of the property.[1] It was believed, however, that such a high rate would tend to reduce traffic and that decreased density of traffic would bring the cost of service per passenger-mile to an even higher figure, and thus entail further increases in fares. In making an average rate of fare below the apparent cost of service, it was hoped that traffic would be sufficiently stimulated after a while to make this rate of fare reasonably profitable. On Oct. 28, 1914, a supplementary order further revising fares and zones was handed down by the Commission as a result of certain petitions and complaints filed by the public, alleging that the hardships and benefits worked by the establishment of the first order were not equally borne by the patrons of the suburban lines. The supplementary order still further reduced fares by ordering the sale of 30 zone tickets for 50 cts. (1⅔ cts. per zone), eliminating one zone on the South Milwaukee line and making minor changes on certain other lines.

As all but two of the suburban lines were divided into either one or two zones only, the result was a distinct decrease in fares for a great many passengers. On such lines as North Milwaukee, or Wauwautosa, for instance, a passenger who formerly paid a 5-ct. fare after crossing the city-fare limits, now pays only 1 or 2 zone tickets worth 1⅔ or 3⅓ cts. respectively, depending on whether he gets off the car in the first or second zone. The average fare on some of these suburban lines was formerly somewhat less than 5 cts., because of the sale of special tickets at a rate which amounted to 3¾ cts. for the regular 5-ct. zone.

Data of passenger traffic and earnings by lines, lengths of zones, etc., have been secured from the Milwaukee Light, Heat & Traction Co.,[2] for the years 1913, 1914 and 1915. From these data Tables VIII and IX have been prepared in an attempt to show comparisons of traffic and earnings before and after the installation of the zone system. The new system of fares

[1] Wisconsin Railroad Commission Reports, vol. 13, pp. 488–489.

[2] Checked with data in possession of Wisconsin Railroad Commission.

went into effect on Jan. 18, 1914, 16 days after the date of the order in which they were prescribed. The order of Oct. 28, 1914, requiring the sale of zone tickets at the rate of 30 for 50 cts. went into effect Nov. 19. As a result, the figures for the calendar year 1914 include earnings at a variety of rates.

The figures for 1913 are made up from operation under the so-called 5-ct. zone system, but because of the use of commutation tickets, sold at a 25 per cent. discount, as explained above, the average fare per revenue passenger on the suburban lines was somewhat less than 5 cts. The company, prior to 1914, had followed the practice of issuing transfers from city lines to suburban lines and it is, therefore, necessary, in computing the number who would have been counted as revenue passengers had the 1914 zone system been in effect, to include the number of transfers from city lines lifted on interurban lines. This will explain the inclusion of so-called transfer passengers with revenue passengers in determining the actual number of paying riders on the suburban lines in 1913.

In the tables, the Whitefish Bay line and the Fox Point line are listed separately. They are really a single line, the Fox Point line being merely a continuation of the Whitefish Bay line.

On seven out of the ten lines, the average fare per passenger was materially decreased by the zone system as shown by a comparison of the 1914 figures with those for 1913. On three lines, namely Whitefish Bay, Tippecanoe, and South Milwaukee, the average fare was increased. In 1915, every line showed a decrease in average fare over 1914, due to the zone ticket rate of 30 for 50 cts., or 1⅔ cts. each.

Five of the seven lines on which average fares were reduced by the zone system have shown an increase in traffic, *i.e.*, the number of revenue passengers carried has been larger, but the increases in the number of passengers have not been sufficient to compensate for the decreased rate at which they are carried.

On the Whitefish Bay and the South Milwaukee lines where average fares were increased, there have been traffic losses, and on these lines also, gross revenues were less in 1915 than in 1913. On the South Milwaukee line, the 1914 gross revenue showed a material increase over 1913, but the elimination of one zone and the consequent reduction in average fare by the order of Oct. 28, 1914, which decreased the rate from 2 cts. to 1⅔ cts. for each zone, caused the 1915 gross revenue to decrease. The Tippecanoe line is the only one which seemed to derive any revenue increase from the zone system. As previously explained, the situation here was really the shortening of a city line by the addition of an extra 1⅔ ct. zone at the outer end. As this end of the line previously had no separate revenue distinct from the city fares, it naturally earned some extra revenue, since everybody who rode in this new zone had to pay the zone fare for the suburban haul.

Increases and losses of traffic cannot be ascribed wholly to the changes in fares. The business depression of the latter part of 1914 and first half of 1915 undoubtedly tended to generally decrease riding on the street cars. Inasmuch as the biggest drop in gross revenue came in 1915, and as fewer revenue passengers were carried even at lower average fares, no very definite conclusions as to the results of the zone system can be drawn from this experience. It would seem that the order compelling the sale of 30 tickets for 50 cts. had the most effect, for in 1915, with only a 1.14 per cent. decrease in traffic over 1914, there was a 13.5 per cent. decrease in gross revenue, in other words, about 91 per cent. of the loss in revenue was due to lower fares and 9 per cent. to less riding. We are not in possession of complete data of the operating expenses, taxes and depreciation requirements of these different lines, nor of the investment in property, consequently we are not able to determine the adequacy or inadequacy of the gross revenue of each of these three years. A glance at the columns showing earnings per car-mile, in 1915, varying from 7.95 to 27.87 cts. per car-mile with the average at 23.20 cts., will give rise to serious doubts as to the adequacy of the revenue. Apparently the Commission did not intend to decrease revenues, as it recognized the very low average rate of return earned at that time by the property which the company was devoting to this service. The Commission was undoubtedly exercising good judgment when it refrained from installing the 2.75 ct. rate called for by the cost analysis, and perhaps under the circumstances a 2-ct. rate was the best one to begin with, but in the light of later developments, it is hard to see wherein the supplementary general reduction to 1⅔ cts. per zone was justified.

A more advantageous form of reduction might possibly be found in changing the minimum charge made for a short ride within one or two zones of the suburban system. Present regulations call for a minimum fare of 5 cts. each, or 3 zone tickets for any single ride on one line originating and ending within the limits of the suburban district. Instead of giving a passenger the advantage of the zone rate for a short ride of one or two zones, he is charged for at least three zones, whether he rides that far or not. Such a minimum charge puts a premium on walking. Of course this rule does not apply to riders to or from the city district. This class pays only for the actual number of zones ridden in, whether one, two, or more, in connection with the city fare.

The fact that since the installation of the zone system, these lines have suffered from decreasing gross revenue cannot be interpreted as a failure of the zone system. It is clear that in the case of the Milwaukee suburban lines, the original 5-ct. fare zones were in many cases very short, giving a high rate of fare per mile. To ride a mile beyond the city-fare limits, many people formerly paid 5 cts., whereas now they pay 2 cts. when paying cash fare, or only 1⅔ cts., if tickets are presented. The effect of the new rate of fare established, and the division of fare limits into short zones, was to materially reduce the average fare

TABLE VIII.—COMPARISON OF LENGTH OF ZONES UNDER FORMER AND PRESENT ZONE SYSTEMS OF FARES IN MILWAUKEE CITY AND SUBURBAN DISTRICT

(Distances Measured Along Actual Route)

In Miles

Line	City fare limits		Suburban zones							
			Former 5 ct. zones		Present 2-ct. zones					
	Former, miles	Present, miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles	Miles
No. Milwaukee–12th St.	4.70	4.70	2.65	...	1.53	1.12				
Wanderer's Rest–Walnut	4.10	4.10	1.44	...	1.06	0.38				
Wauwatosa–Walnut....	4.80	4.80	1.44	...	1.44	0.00				
Wauwatosa–Wells......	4.50	4.50	1.86	...	1.08	0.78				
West Allis–Burnham....	5.78	5.78	2.14	...	1.61	0.53				
West Allis–Fond-du-lac..	5.49	5.49	1.61	...	1.08	0.53				
Whitefish Bay–Fox Pt..	4.26	4.26	3.84	2.01	0.98	1.07	0.84	0.95	0.78	1.23
Oklahoma–Cudahy–S. Mil...............	4.90	4.90[1]	6.58 7.21	...	1.50	1.29	1.01	0.88	0.88 1.52	1.02 1.01
Tippecanoe............	5.42	4.42	...	...	1.00					

[1] By the Order of Jan. 2, 1914, this was made 4.0 miles, and extended to its former limit of 4.90 by the Order of Oct. 28, 1914.

Distances to city fare limits measured from traffic center of city.

TABLE IX.—MILWAUKEE LIGHT, HEAT & TRACTION CO.

Passenger Traffic and Revenue in Suburban District Before and After Inauguration of Zone System

Line	Number of zones		Average fare			No. of revenue passengers			Passenger revenue			Revenue per car-mile		
	1913	1914–15	1913	1914	1915	1913	1914	1915	1913	1914	1915	1913	1914	1915
			Cents	Cents	Cents				Dollars	Dollars	Dollars	Cents	Cents	Cents
No. Milwaukee (12th St.)........	1–5-ct.	2–2-ct.	4.32	3.25	2.96	504,812	507,069	547,626	21,812	16,484	16,228	25.85	19.67	19.53
Wanderer's Rest (Walnut St.)....	1–5-ct.	2–2-ct.	4.99	3.56	3.34	132,113	142,998	151,925	6,595	5,095	5,080	20.68	15.11	14.69
Wauwautosa (Walnut St.).......	1–5-ct.	1–2-ct.	4.17	2.08	1.89	307,728	348,952	326,364	12,829	7,262	6,170	32.69	18.47	15.65
Wauwautosa (Wells St.).........	1–5-ct.	2–2-ct.	3.97	2.95	2.65	747,681	769,665	776,918	29,690	22,680	20,591	38.19	28.47	24.95
West Allis (Burnham)[1]..........	1–5-ct.	2–2-ct.	3.90	3.56	3.49	554,668	542,289	553,160	21,612	19,329	19,286	25.19	23.49	22.18
West Allis (Fond-du-lac)[1]........	1–5-ct.	2–2-ct.	3.79	3.26	3.29	906,837	919,896	905,682	34,374	30,031	29,821	32.56	28.59	27.87
Whitefish Bay (Oakland)........	1–5-ct.	4–2-ct.	4.57	5.05	5.32	478,864	411,353	297,593	21,907	20,771	15,840	25.10	24.83	23.65
Fox Point (Oakland)............	1–5-ct.	2–2-ct.	5.00	3.48	2.94	86,968	104,507	92,667	4,351	3,634	2,727	13.27	10.58	7.95
Tippecanoe....................	Cityline	1–2-ct.	...	2.72	1.84	....	271,338	260,705	......	7,392	4,794	...	11.75	10.27
St. Francis-Cudahy-So. Milw.[1]....	1–5-ct.	6–2-ct.	4.36	5.87	4.69	2,232,151	1,935,978	1,973,387	97,245	113,584	92,592	26.67	29.72	27.47
Totals........................	.....	.....	4.21	4.14	3.62	5,951,822	5,954,045	5,886,027	250,415	246,262	213,129	27.54	24.96	23.20

[1] Lines starred include interurban data in suburban limits.

paid by the majority of car-riders going beyond the city limits. On the few lines, where because of their greater length the average fare was increased, the attitude of the public toward the change, together with the business depression, combined to cut down the annual passenger traffic temporarily at least. The general reduction in average fare was too great to be offset by any possible traffic increases in the course of 1 or 2 years, and general business conditions were also adverse. The low population density along many of the suburban lines results in a naturally low traffic density, and some years of development must intervene before these lines become really profitable.

The Milwaukee application of the zone system cannot be accepted as an illustration of what the effect would be of installing a zone system within the limits of some existing 5-ct. fare area of a large American city.

CHAPTER IX

SOME COMPARISONS OF AMERICAN AND BRITISH FARE SYSTEMS

While urban street railway transportation in America has developed along the lines of the flat-rate system of fares for any length of ride, the practice abroad has been to limit the length of ride for the unit fare, and to adopt smaller units than the American "nickel." The unit of fare in Great Britain has generally been the penny (approximately 2 cts., U. S.) but in recent years there has been a growing tendency toward the even smaller half-penny unit (1 ct. U. S.).

It is frequently asked why and how the British tramways can carry passengers for 1 and 2 cts. apiece, while many American street railways are unprofitable at 5 cts. The fact that the majority of important British tramways are owned and operated by the municipal authorities is often advanced by exponents of public ownership in this country as the prime factor in their cheap service. It is essential, in an investigation such as is being made by this Research, that some consideration be given to this question. Absolutely impartial comparisons have been very rare, for the gathering of statistics and information has generally been done by parties representing directly or indirectly, either the private-ownership interests, or the proponents of public-ownership doctrines.

While it may be impracticable to present complete data and to formulate decisive conclusions without a more extended research upon this particular subject, the following statistics and information have been prepared from the annual reports of some 16 of the largest British tramways, from direct correspondence with British tramway officials, and from various other sources acknowledged in the course of the text.

All data and statistics on this subject relate to conditions prior to the outbreak of the European war.

Factors Influencing Lower Fares.—In the mass of conflicting opinions and data published on the subject of the British tramway situation, many suggestions have been offered in explanation of the low fares. The pro-public-ownership people claim that the British municipalities furnish the service at cost, and that the privately owned American companies make big profits; moreover, they frequently give credit to the British officials for more efficient and more economical management. On the other hand, American street railway owners claim that they do not make big profits, that they give more and better service than the British lines, furnish longer rides and pay more in taxes, that wages and costs of materials are higher here and that the density of traffic is less.

It will be advantageous to consider separately and in detail each of the following factors which may tend to influence these apparently different conditions at home and abroad. These factors are:

1. Rates of fare and length of haul.
2. Free transfer privileges.
3. Density of traffic and of population.
4. Rapid transit.
5. Wages and cost of material.
6. Investment.
7. Interest rates, profits and taxes.

Rates of Fare and Length of Haul.—The most general statement that can be made about the rates of fare and length of haul on British tramways is that the fares are usually proportioned to the distance the passenger rides and may be considered as approximately 1 ct. per mile in the largest cities. There are, however, many places in which the ordinary passenger pays more than a cent a mile, and some places less. In the *Tramway and Railway World*, of April 15, 1915, the statistics of 85 British and 1 Colonial Municipal tramways[1] are published, and the average distance for a 1-d. (2-ct.) fare is tabulated for 78 of them. Of these only 9 give a ride of more than 2 miles for 2 cts. Nine give a length of ride between 1¾ and 2 miles, and 17 give between 1½ and 1¾ miles. The remaining 43 allow from 0.85 to 1.5 miles for 1 d. (2 cts.). Practically all of the municipally owned tramways in England, Scotland and Ireland are included.

A chart (Fig. 55) has been prepared to show the lengths of ride allowed for the ½-d. (1-ct.), 1-d. (2-ct.) and 2½-d. (5-ct.) fares

[1] Of the 86 reported, 76 are in England and Wales, 8 are in Scotland, 1 in Ireland, and 1 in New Zealand.

in some of the British cities most frequently mentioned for their low fares. The statistics have been taken from various sources, and include one private company, the London United Tramways, which was not included in the above-mentioned list of 86 municipal tramways. The privately owned company gives a haul of 2¼ miles for 1 d. (2 cts.).

In addition to these distances for ordinary fares, there are a number of special fares in many of the British cities. The

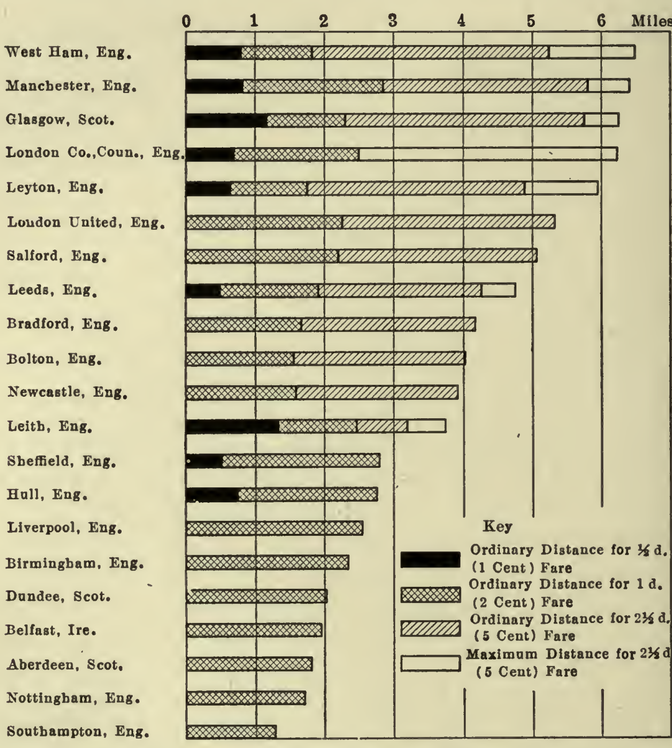

Fig. 55.—Length of ride for ordinary fares on British tramways in 1914.

majority of the larger British tramways offer reduced rates to workingmen in the early morning and the evening hours, and half rates for children. Special "return" tickets are sold by some tramways. On the whole the number of passengers using other than ordinary rates of fare seems to be less than 25 per cent. of the total, and is generally from 10 to 15 per cent.

As a general proposition the tramway lines are divided up into a number of fare stages or zones of moderate length, and a small increment of fare is charged for each added stage travelled through. The fare for the whole distance is usually collected at once, and a punched or colored identification slip given to the passenger as a receipt. The conductor, or in some cases a special inspector, goes through the car frequently to see that no passenger is riding beyond the limit to which he has paid his fare as shown by the identification slip.

A study has been made of statistics furnished by several of the British tramways, as to rates of fare for various stages and the numbers of passengers paying these various rates of fare. Assuming that each class of passengers ride the full permissible distance for the fare paid, it is possible to figure approximately the average length of ride of all passengers. This assumption is not unreasonable, for the various distances for each extra ½ d. (1 ct.) are generally about 1 mile and a passenger is apt to ride to the end of the stage nearest his destination and walk the remaining distance, if it is not too great.

It appears that in the great majority of cases, a very large proportion of all the passengers pay the 1-d. (2-ct.) rate and ride about 2 miles, and that the average ride of all passengers is generally only a trifle over 2 miles. London and Glasgow are exceptions, the ½-d. (1-ct.) fare being popular in these cities. In some cases the average fare per mile figures out a trifle less than 1 ct. per mile, and in others more, even when workingmen's reduced fares and special round trip rates are considered.

Referring again to the chart (Fig. 55), it will be seen that the maximum ride given for 2½ d. (5 cts.) is in West Ham, where 6.5 miles is the limit. Manchester, London and Glasgow have a maximum 5-ct. ride of slightly over 6 miles.

In many large American cities, one may ride from 10 to 15 miles for a single 5-ct. fare payment. The maps of single-fare areas of American cities, Figs. 36 and 37, indicate the long rides that may be had for 5 cts. in this country. Although these very long rides are possible, the average is much lower, due to many comparatively short rides for which the fare unit is the same. From the results of many traffic counts which have been made and reported by various authorities, it would appear that the average ride on the street railways of the ordinary American city is between 2.5 and 3.5 miles, perhaps more in the largest cities. At a 5-ct.

fare, these distances give average rates of between 2.00 and 1.43 cts. per mile, or perhaps a trifle less in the largest cities.[1]

It appears evident then, that the average American passenger pays a higher rate of fare per mile travelled than the average on the British tramways, and that the majority of traffic on the British tramways is short-riding at a lower unit fare than the American 5-ct. unit.

Free Transfer Privileges.—The free transfer privilege as known in this country is practically non-existent in Great Britain. Out of 90 municipal tramway undertakings in Great

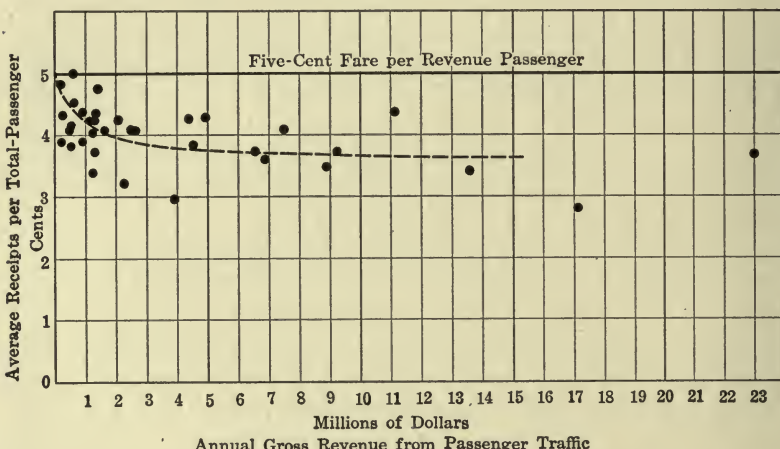

Fig. 56.—Apparent reduction of average fare per passenger by use of free transfers on city systems in the United States.

Britain, only 33 have any form of transfer ticket in use, and these, with the exception of the London County Council, are all on the smaller systems, and are generally limited to special routes and conditions.[2] In view of the fact that passengers can ride additional short distances for ½ d. or 1 d., there seems to be less reason for the use of free transfers.

In American cities, the actual average fare per ride on a car is much less than 5 cts. due to the very extensive practice which has grown up, of allowing one or more free transfers between

[1] The 1912 Special Report of the U. S. Bureau of Census shows that nearly 500 individual cities and towns in the United States have some form of special street railway fares lower than 5 cts.

[2] From "The Passenger Transportation Problem" report of the Tramways Department, City of Manchester, England.

connecting lines. The amount of transferring varies from nothing, up to an estimated ratio, in the case of the Boston Elevated Railway Co., of 77 per cent. of the total number of revenue passengers. The latter figure is unusually high, the average in moderate-sized American cities being roughly from 10 to 30 per cent., and up to 50 per cent. in the larger ones. The effect of this transfer privilege on the average fare per total passenger is shown in Fig. 56.

These facts, however, do not alter the conclusion reached above, that the average fare per mile on British tramways is less than that on the American systems.

Density of Traffic and of Population.—While the British tramways are by no means identical with the American ones as to investment and cost of operation, it is an established fact that they enjoy a much higher density of traffic. While the American companies carry from 4 to 7 revenue passengers per car-mile at about 5 cts. each, the British companies carry from 7 to 13 at an average of a little more than 2 cts. apiece, so that the difference in cash revenue per car-mile is by no means as great as the difference in average fares. The statistics in the *Tramway and Railway World*, April 15, 1915, show that of the 86 tramway systems reported, 52 have a revenue per car-mile of over 20 cts. Due to the shorter rides and denser population, the tramcars are able to pick up and drop more passengers in each mile of route than the American cars.

England and Wales, with an area of 58,575 sq. miles, and a population of about 36,000,000 persons, had in 1913 a total of only 3,550 miles of single main tramway track, while the State of Massachusetts alone, with an area of only 8,300 sq. miles and a population of only about 3,500,000 had 2,832 miles of single main track for street railways. On the 3,550 miles of British tramway tracks, an average of 730,000 passengers per mile were carried, while in Massachusetts, the corresponding average was 260,000 in the year 1912–1913. The gross transportation revenue per mile of track operated in England and Wales was $17,100, in Massachusetts it was only $13,460. In England and Wales there was only 1 mile of track for every 10,000 inhabitants, in Massachusetts there was 1 mile for every 1,270 inhabitants. In the whole United States, there was in 1912 a total single main track mileage of 38,334,[1] for a population

[1] 1912 Report of the U. S. Bureau of Census, p. 282.

of about 95,000,000, or 1 mile of electric railway track for every 2,500 inhabitants.

These figures indicate that American communities have far more street railway facilities in proportion to their population and area than England and Wales, but they contribute less revenue per mile of track operated. It would appear that in Great Britain, tramways have been built and operated only in communities where the conditions are most favorable, namely, in the densely populated portions of cities and towns, while the American policy has been to open up sparsely settled suburbs and rural districts by the extension of city lines and the construction of interurban lines.

Rapid Transit.—It has been claimed that American street railway transportation is at a higher rate of speed than that of the British systems. In the statistics mentioned before, published in the *Tramway and Railway World* of April 15, 1915, the average speeds on the 86 Municipal tramways reported vary from 5.5 miles per hour to 9.5 miles per hour. These values are obtained by dividing the total car mileage by the number of car-hours. The majority appear to average about 7 to 8 miles per hour. The corresponding average for all Massachusetts roads in 1914 was 9.85 miles per hour. The higher Massachusetts average is due to the large amount of high-speed service on the subway and elevated lines of the Boston Elevated Railway Co., and also to the higher schedule speed of suburban lines.

The speed of surface electric cars in city service is limited by frequent stops and street congestion, and there is not likely to be any very material difference in the average speed of cars in American and British cities.

Wages.—One of the most essential factors in the lower average fare on British tramways, next to density of traffic, is the much lower wage scale paid to employees. It was shown in Chapter VI, that as an average on all Massachusetts street railways, over 1 ct. per revenue passenger goes to paying the wages of motormen and conductors.

The wages of motormen and conductors in England are about one-half of those of American street railways, whether figured on an hourly or a weekly basis. In the "Municipal Year Book" of the United Kingdom for 1914, published in London, the rates of pay of tramway employees on practically all the municipally owned systems are given. For first year motormen and conductors the rates vary from 2 to 7¼ d. (4 to 14½ cts.) per hour, and the maximum after 5 years service, varies from 3 to 7.8 d. (6 to 15.6 cts.) per hour. The hours of service vary from 51 to 63 hr. per week, so that even at the maximum rate for a week of seven 9-hr. days, the highest paid man's weekly pay would be less than $10.[1]

In this country the wages of motormen and conductors seem to range from about 20 cts. per hour to 35 cts. per hour according to length of service, locality, etc. It is safe to say that for systems operating in cities in the eastern part of the country, 23 to 30 cts. per hour is about the average range, with a continuous tendency toward higher rates.

The resulting effect on the fares of this difference in carmen's wages is shown by noticing that while the average American passenger contributes about 1 ct. of his 5-ct. fare toward wages of motormen and conductors, the average contributed by each passenger out of his fare in Great Britain is appreciably less than ½ ct. In London (County Council tramways) the average is 0.49 ct. per passenger, in Liverpool 0.42 ct., in Manchester 0.41 ct., in Birmingham 0.43 ct.; in Sheffield 0.40 ct., in Leeds 0.42 ct., etc. The figures for Massachusetts roads in Chapter VI showed the following: Boston Elevated, 1.15 cts., Worcester Consolidated 1.05 cts., Springfield 1.30 cts., Union (New Bedford) 1.08 cts., and Holyoke 1.17 cts. while the average for all Massachusetts roads (1914–1915) was 1.14 cts. per revenue passenger.

Other wages for skilled and unskilled labor are much lower in Great Britain than in the United States. Of the several British tramway reports received, only one, West Ham, gave a full list of its wage scale. The West Ham Corporation Tramways may or may not be typical of the average case, but at least it cannot be far off, as it is a system serving a population of nearly 300,000 persons. The following table gives part of the West Ham wage list embracing the most important branches of labor, and the corresponding figures for Massachusetts street railways have been taken from the 45th Annual Report of the Statistics of Labor, published by the Commonwealth of Massachusetts. The wide range in the case of Massachusetts wages usually covers both the minimum and maximum extremes and in general the average probably lies approximately halfway between the extremes.

[1] As stated before, all statistics refer to conditions prior to the war.

Occupation	Wage scale in West Ham, England[1]	Wages in Massachusetts
Inspectors and timekeepers..	\$9.00 to \$10.90 per week	Not given
Motormen.................	14½ cts. per hour	20 to 32 cts. per hour
Conductors................	14½ cts. per hour	20 to 32 cts. per hour
Blacksmiths...............	20 cts. per hour	30 to 39 cts. per hour
Wiremen..................	19 cts. per hour	30 to 41 cts. per hour
Armature winders..........	18 to 19 cts. per hour	19 to 40 cts. per hour
Painters..................	17½ to 18½ cts. per hour	20 to 33 cts. per hour
Car cleaners...............	14 cts. per hour	21 cts. per hour
Laborers..................	14 cts. per hour	21½ cts per. hour
Linemen (ordinary).........	\$11.50 per week	\$15.66 to \$23.10 per week
Linemen (foremen).........	\$12.15 per week	\$20 to \$25 per week

"The Municipal Year Book," previously mentioned, gives a list of wages of various common forms of skilled and unskilled labor in the municipal employ in over 100 British cities. These wages range as follows:

	Cts. per hour
Concretors and laborers......................	9 to 17
Bricklayers and laborers.....................	11 to 23
Carpenters and joiners.......................	10 to 23
Painters....................................	10 to 21
Navvies (pick and shovel men)...............	10 to 16
Sewer pipe layers...........................	12 to 20
General laborers............................	10 to 16

Figures for approximately corresponding forms of labor in Massachusetts according to the Massachusetts 45th Annual Report of Labor Statistics, 1914, were:

	Cts. per hour
Concrete mixers (municipal)..................	34
Cement workers and helpers..................	30 to 65
Bricklayers.................................	47 to 65
Carpenters (rough outside work on street railways)................................	20 to 36
Carpenters (wharf and bridge men)...........	29 to 47
Carpenters (shop and mill men)..............	28 to 45
Painters (rough work).......................	20 to 33
Painters (house painters)...................	28 to 50
Laborers (municipal work)...................	20 to 31
Pipe layers (municipal work)................	34

[1] Changes to U. S. coinage on basis 1 d. = 2 cts., 1 s. = 24⅓ cts.

From the preceding comparisons, it is evident that American wages paid by the street railways are at least 50 per cent. higher than British standards, and frequently from 75 to 100 per cent. higher.

Investment.—It was shown earlier in this report, in discussing the costs and investments of American street railways, that comparisons based on the revenue passenger unit of investment, were most significant. In studying the British conditions in comparison with the situation in America, this unit of investment will at least throw some light on the low-fare question as regards the smaller amounts per passenger which go to paying for interest on the debt of the British companies. The total "Capital Expenditure" of the British tramways reported in the *Tramway and Railway World*[1] was about $240,000,000 and in the corresponding year 2,676,000,000 passengers were carried, which indicates a capital expenditure per passenger carried per year of about 9 cts. The average gross revenue per passenger was 2.12.[2] As shown in the plot, Fig. 3, the American systems have from about 13 to more than 50 cts. invested per revenue passenger carried. Moreover, the British municipalities have managed to amortize part of this capital expenditure out of earnings, so that their total funded indebtedness (they have no stock issues) is now only about $179,000,000 or about 6.7 cts. per passenger, while the average funded debt and capital stock outstanding for all roads in Massachusetts is something over 25 cts. per revenue passenger, or nearly four times as great. Part of this difference can be ascribed to the higher density of traffic in Great Britain, part to the shorter average haul of passengers, and part to the fact that the majority of these British tramways have no investment in power plants. As to whether or not the greater capital outlay per revenue passenger in America is further explained by possibly higher costs of labor and material and greater city requirements for paving and other street improvements has not been investigated.

Interest Rates, Profits and Taxes.—The one most self-evident advantage of the British municipal tramway systems over their contemporaries in America is the low rate of interest at which they can borrow money. The British Municipal tramways are built with borrowed money, for which bonds are issued.

[1] April 15, 1915.

[2] Average fare per passenger was 2.07 cts.

There is no sale of capital stock as the ownership of the tramways is vested in the municipal governments. On the total funded indebtedness of $179,000,000 of the 86 tramways mentioned in the preceding paragraph, the total interest paid was $6,310,000, or an average rate of about 3½ per cent. It has been shown in the preceding chapters of this report that fairly successful American companies are actually paying an average of from 5 to 8 per cent. on money actually invested, and that there is a pretty general complaint that 5 per cent. is too low an average. Interest rates in America, it would seem, must be generally higher than in Great Britian, as is natural for a newer country with its industries in process of development. Ordinary savings banks here will pay from 3½ to 4 per cent. on small savings accounts, while the coöperative type of bank frequently pays 5 per cent. Certainly, no private capital can be found here to enter the street railway business at 3½ per cent. If American municipalities undertook to purchase and operate the street railways they could probably obtain capital at a somewhat lower rate than the present privately owned enterprises can. Even now, in the United States, municipal bonds are generally sold at rates netting 4 to 6 per cent., the former being ordinary in well-established Eastern cities and towns and the latter in newer communities of small size. Some of the larger and stronger Eastern cities even have bonds outstanding at 3 and 3½ per cent., but present-day issues for waterworks, sewer construction and similar municipal improvements generally net 4 per cent. or higher.[1] Should American municipalities undertake the ownership of the street railways on any extensive scale, it is not at all impossible that interest rates on municipal bond offerings would be increased in proportion to the increased risks of the business ventures of the cities.

The low interest rates in Great Britian combined with the low average debt per passenger make the requirements per passenger for return on investment very low. The average, as determined from the statistics of the 86 tramways quoted above is only 0.24 ct. per passenger, as against a little over 1 ct. for most Massachusetts companies. As mentioned above, however, these British municipal tramways are endeavoring to amortize their capital indebtedness, and while apparently keeping up their

[1] See list of quotations on municipal bonds in current numbers of the *Commercial and Financial Chronicle,* published weekly in New York.

repairs and renewals accounts at least as well as the American companies, they are also applying very considerable portions of their income toward a reduction of their debts. The same list of accounts of the 86 tramways shows that over $6,600,000 was charged off to "Sinking Fund," and while it was not expressly stated that this sinking fund was devoted to reducing the capital debt, it seems certain from a comparison with the more detailed reports of a number of individual companies that the sinking fund is devoted to this purpose. This amount was greater than the total payments in interest or debt, and amounts to 0.25 ct. per passenger.[1] The combined amount for interest and amortization on these British tramways per passenger carried, appears to be about one-half the requirements for return on investment per passenger of the Massachusetts roads.

There seems to be a great deal of misunderstanding as to the disposition of profits and the levying of taxes in the two countries. The British municipal tramways do not pay direct taxes, while American companies as previously shown, contribute from 4 to 8 per cent. of their gross revenue, or from 0.2 and 0.4 ct. per revenue passenger to the local and State governments as direct taxes. In addition, the American companies carry various expenses due to street paving, snow removal, etc. The British tramways apparently have similar paving and street improvement expenses. As for profits, there are not many American companies which are able to make more than a 5 or 6 per cent. return on actual cash investment, but the few more prosperous ones usually pay any additional profits to the stockholders in the form of higher dividends.

In the case of the British municipal tramways, the earnings over and above the expenses and interest on capital, are used partially in amortizing the debt, and partially "in relief of rates" which is a payment by the tramway department into the city treasury corresponding to the taxes levied on private property. These "contributions" being voluntary, they are made only by the profitable tramways in profitable years. On the other hand, municipally owned tramways operating at a loss must be supported by contributions from the rates, *i.e.*, by the general taxpayers. Of the 86 tramways previously mentioned, only 38 contributed anything in relief of rates, this being for the fiscal

[1] This means that the present-day passenger is paying the construction cost for the benefit of future riders.

year ending in 1913, or the early part of 1914, before war conditions prevailed. The statistics fail to show how many were aided by the taxpayers. However, a few of the very profitable British tramways made large contributions in relief of rates, so that the total amount contributed by the 38 contributing companies reached the very respectable figure of $3,000,000. As these 38 systems carried about 1,740,000,000 passengers, the average per passenger would be about 0.17 ct. as compared with 0.32 ct. per passenger for all Massachusetts systems. If all the British systems which paid nothing are averaged with those actually making payments, the result is 0.11 ct. per passenger contributed in relief of rates compared with 0.32 ct. in Massachusetts. The statistics also leave in doubt the question of whether the general tax payers are not in some cases called upon to contribute to the relief of the tramway.

Summary and Conclusions.—The comparisons of the British tramways with American street railways discussed above may be summarized as follows:

1. The British tramway fares are lower than the American. The passenger on the former pays a fare proportionate to the distance he rides at a rate of approximately 1 ct. per mile, and on the average he rides about 2 miles, making the penny, or 2-ct. fare, the most common unit. The American passenger usually pays a flat-rate fare, ordinarily 5 cts., for any distance up to as much as 10 or 15 miles, but as the average ride appears to be only from 2.5 to 3.5 miles, the rate per mile is from 1.4 to 2.0 cts.

2. Instead of using free transfers from one car to another, as in the United States, the British system of fares almost always entails a second payment, although the unit of fare is smaller. This method makes the fare of all individuals more nearly proportional to the service received.

3. The British tramways have a distinct advantage in catering to a much denser population than the American railways, and as a result they obtain nearly twice as many passengers per unit of track and equipment as the Americans.

4. The speed of cars in city service is not materially different in either case, except wherein a few American cities have high-speed subway and elevated lines.

5. Wages of motormen and conductors which form one of the biggest items of expense in street railway operation are approximately twice as great in America as in England. Wages for

other labor, skilled and unskilled, are also much higher in America.

6. The investment and debt per passenger carried is much greater in this country than abroad. Some of the reasons for this difference are the greater density of traffic in England, the amortization of debt out of earnings, and the shorter average ride per passenger. It is also true that the electrification of British tramways was not undertaken until after electricity had been in successful operation in the United States for many years. They thus avoided much of the expense of experimentation which fell upon American companies.

7. Capital can be obtained at an average interest rate of 3½ per cent. in Great Britain,[1] whereas 5 to 6 per cent. as paid in this country does not seem to be sufficient to invite investors. Whether or not municipal ownership would secure a much lower rate is an open question. The freedom of the British municipal tramways from direct taxation, unless they are profitable enough to make voluntary contributions, is an appreciable advantage.

The facts brought out in this chapter do not necessarily prove that American street railways have been constructed and operated in the most economical and efficient manner. It seems evident, however, that if they were to enjoy the dense short-haul traffic of the British tramways, if they could pay their construction and operating labor a wage of approximately half the present American scale, if they could abolish free transfers, borrow capital at 3½ per cent. interest, and escape taxation, they could with their existing managements easily equal the rates of fare which at present exist on the British tramways.

[1] This relates to conditions before the European war. The changes caused by the war may lessen the difference between British and American conditions.

CHAPTER X

LENGTH OF HAUL AS A FACTOR IN A REVISED SYSTEM OF FARES

Reasons for Revising Fare Systems.—Proposals to make changes in fares on street railways almost always arise from one of two causes. Increased fares are usually proposed by the street railway company because of an alleged necessity for increased revenue. Decreased fares are usually proposed by the public, or by parties presumably representing the interests of the public, on the grounds that the saving due to lower fares will be a public benefit, and that because of probable traffic increases, or already ample earnings, the street railway should be able to obtain sufficient revenue at the lower rate.

It is undoubtedly true that many street railways need a more adequate revenue than they are now receiving under the 5-ct. fare system with present operating conditions. The statistics of the Massachusetts street railways, where the average rate of return on actual investment in street railways has declined to about 4.5 per cent., present one item of evidence in this direction. On the other hand, it must be remembered that there are individual companies, both in Massachusetts and elsewhere, that are making amply sufficient earnings at the present-day rate of 5 cts.

A company may find itself in need of increased revenue for a variety of good reasons. The immediate need may be to furnish a better quality of service, to provide a better standard of maintenance, to pay a rate of return which will be sufficient to maintain the financial credit of the company, or the necessity may be gradually brought about by increasing wages and costs of materials.

It was shown in Chapter IV, that a general increase in flat-rate fares tends to reduce traffic, in some cases sufficiently so as to overbalance the gains due to higher unit fares. The loss of short riders is a particularly undesirable feature of the 6 ct., or higher, flat fare.

Desire for Lower Fares.—There are few traction systems in the country which at one time or another have not been subjected to demands for reduction in fares. In the medium-sized cities of the middle West these demands have been pressed with especial vigor, and in several cities such as Cleveland, Detroit, Milwaukee, and a few others, the rate of fare has been reduced below the 5-ct. unit. Demands for reduced fares frequently receive general public support because of the often mistaken notion that the street railway business is an immensely profitable industry and that the private owners are making exorbitant profits at the expense of the public. Such public opinion is due largely to the circumstances attending the early promotion of certain companies when the original promotors did make exorbitant profits and left their successors a heritage of watered stock and depreciated property. The wide publicity given to the affairs of "looted" railways and public utilities bankrupted by inefficient or dishonest management has helped to create an antagonistic public opinion toward all railways and utilities. Equally wide publicity must be given to the other sides of the situation to obtain a finally fair settlement of the problems confronting the industry.

For a short ride of, say 1 to 2 miles, the 5-ct. unit undoubtedly looms large to many persons of small means, and the saving of carfare expense gained by walking outweighs, more often than not, the saving of time and the comfort of riding. The salaried railway official and citizen with a substantial income is scarcely able to put himself in the place of the laborer and the clerk to whom 5 cts. is a really material portion of the daily wage; consequently there is apt to be a lack of appreciation in official circles as to the desirability of low fares.

A Possible Solution.—What appears to be the best way of reconciling, partially at least, these two diverging needs, namely the growing necessity for increased revenues, and the public desire for low fares, is to establish in this country something in the nature of a zone system or distance basis of fares. It may not be possible in all cases to make a unit rate lower than 5 cts., but, for reasonable lengths of haul, fares can and should be kept from going above this rate. In other cases, especially in the larger radial cities, it is believed that there is reasonable possibility that a system of fares can be devised which will give a rate lower than 5 cts. for short hauls within a limited central district, with increasing rates for longer rides. An outline of the general methods and means of providing for the most important details of fare systems based upon length of haul are given in subsequent chapters.

By such a system, the short rider is given the benefit of low rates, which should tend to increase short riding, while the long rider is obliged to pay more nearly in proportion to the cost of the service received. With such a system, there should be less likelihood of reluctance on the part of the street railways to make desirable extensions of lines, for they will not then be forced to look forward to so many years of unprofitable operation of such extensions. It was shown in Chapter III, and in Fig. 21, that the average length of ride tends to increase as the length of line increases.

Under the flat-rate system, when changes in economic conditions such as variations in wages and costs of materials occur, a company must either absorb such changes by countervailing changes in other factors of its expenses, or else attempt to make a horizontal change in the rate of fare. When this entails an increase from 5 to 6 cts. per ride, the discrimination between long riders and short riders becomes accentuated. A fare system based on rates graded according to length of haul is more elastic in this respect, in that the increases in cost, if such occur, can be distributed more equitably among the various patrons.

Sociological Aspect of Basing Fares on Length of Haul.—One of the chief objections which has been raised in the past against any proposal to institute zone or distance rates of fare in this country is that they may tend to retard the growth of suburban districts and cause congestion of population in the cities. Statistics of density of population in European cities, where the zone system of fares has always existed, have been compared with similar data of American cities and, because the former generally show a greater density of population than the latter, the hasty conclusion has been drawn that the zone system is responsible for the congestion of population.

If the rates of fare on urban street railways were the only factor which affected the distribution of population, such comparisons might have some claim to conclusiveness. The fact is, however, that little or no weight can be attached to density of urban population in American cities as compared to that in foreign cities with respect to its relation to tramway fares.

In the first place, the majority of European cities are far older than American cities, and many of them have been noted for their tremendously congested slums for many years before the era of street railway transportation. In addition to the influence of the system and relative magnitude of rates for transportation, the distribution of population is affected by (1) rents, (2) time consumed by transportation service, (3) character of population, (4) comparative wages, prices and standards of living.

The very poorest people are generally found in the most congested central districts, not only because they can save carfare altogether by walking to their places of employment, but also because rents are generally cheapest in such quarters. The poorer classes of foreigners are generally found crowded together in American city centers, partly because they do not want to spend carfares, but also because they like to be associated with their own countrymen.

Not a few people remain in congested city quarters because they will not spare the time to travel back and forth to the less crowded suburbs. The large class of "apartment" dwellers in all cities bears witness to this factor in the situation.

Because of these conditions, there are certain parts of American cities, notably New York, in which the congestion, or density of population, is comparable with that in European cities, despite the fact that, for 5 cts., one may ride many miles from the slum districts of the city.

The fact is that there will probably always be a considerable part of the population unable to pay any rate of carfare to get out of the crowded districts, and other parts of the population unwilling to spend the time required for transportation to any appreciable distance from the business or pleasure centers. With a zone system of fares in America, it is reasonable to assume at least that some of the poorer classes might be carried a little way out if the first unit fare were 3 or 3½ cts., where now 5 cts. is too much for them. Again, if the street railways should succeed in achieving a better financial condition by means of a system of fares based partially, at least, on length of haul, they would be in a position to make desirable extensions opening up new territory, and to improve their service and speed, thus making transportation more attractive to some who now stay in the city for a supposedly greater convenience or comfort.

It hardly seems possible that a slight difference of fare between long and short rides could seriously affect the living and housing conditions of the population. The matter of congestion of population in urban districts is not, in itself, of any serious importance. It is the relation of congestion to public health and education that is really vital, and proper legislation and efficient administration can be made to take care of the problem. In England and in Germany, much has been done in this manner to eradicate the fearful slums which were formerly such a source of reproach to the large cities.

When a street railway is shown to be in real need of increased revenue, it can hardly be expected to continue operation at a flat 5-ct. fare, solely because some people believe such a system helps to avoid congestion of population. A privately owned transportation company cannot be run at a loss for a supposed philanthropic purpose. If population is congested, or is in danger of becoming so, it is a proper function of government to provide against it, by proper regulation of tenements, for the general good of the community.

It has been demonstrated in this report that flat rate fares of 6 or more cts., are undesirable, as they discourage short riding. If street railways generally have to come to some form of increased fares in this country, a flat rate of 6 or 7 cts. will be just so much more beyond the reach of the very poor, while a 5-ct. or lower rate, even if good for only a 2- or 3-mile ride, would be of more value to the community as a whole, as an inducement to draw the people at least a little way from the most crowded quarters.

CHAPTER XI

AN ANALYSIS OF FORMULAS FOR LENGTH OF PAYING HAUL. METHODS PROPOSED BY MR. FORD, MR. BRADLEE, AND BY THE WISCONSIN RAILROAD COMMISSION

Paying Haul (*Investigations of Messrs. Ford, Bradlee, and the Wisconsin Railroad Commission*).—With the object in view of determining the allowable or paying passenger haul, Mr. Frank R. Ford, Mr. Henry G. Bradlee and the Wisconsin Railroad Commission have devised their several formulas. The Ford formula and that of the Wisconsin Commission are in terms of passenger-miles, while the Bradlee method is in terms of car haul or length of route. Although stated in different ways, these three formulas for determining the paying haul simply depend upon the common-sense reasoning that the actual average haul must be adjusted until receipts equal expenses, where expenses in lude a fair return on a reasonable capitalization and a reasonable provision for renewals and replacements in addition to the usual operating expenses and taxes.

Notation Used in Discussing Formulas.—For the sake of brevity and consistency in the discussion of the various formulas for computing paying haul, the following notation will be used throughout:

B = total number of round trips per annum.

D_1 = average total distance a passenger rides after readjustment of fare limits (see H_1).

F = actual annual charges other than usual operating expenses and return on investment.

F_1 = reasonable annual charges, including renewals, but excluding other operating expenses and return on investment.

H = actual average length of ride per unit fare (from traffic study).

H_1 = allowable or paying average length of ride, after readjustment, per original unit fare (U).

I = total investment or capital by book accounts.

I_1 = reasonable total investment by valuation.

L = actual average car haul per half round trip.

L_1 = average paying car haul per half round trip.

M_1 = reasonable "movement" cost per annum as determined by Wisconsin Commission method (see T_1).
N = actual total car-miles per annum.
P = actual total number of revenue passengers per annum.
P_1 = total number of revenue passengers carried per annum after readjustment of fare limits.
R = actual total passenger receipts per annum.
R_1 = total passenger receipts per annum after readjustment of fare limits.
r = actual average rate of return (as a fraction) on book investment I.
r_1 = fair rate of return (as a fraction) on *reasonable* investment I_1.
T_1 = reasonable "terminal" cost per annum as determined by Wisconsin Commission method (see M_1).
U = original unit fare.
W = actual total operating expenses per annum exclusive of renewals.
W_1 = total operating expenses per annum exclusive of renewals, after readjustment of fare limits.

If the company derives any considerable income from sources other than passenger revenue, then in the preceding notation, the values of investment, fixed charges and operating expenses should be only such portion of the totals as are actually devoted to passenger business.

Fundamental Principles Governing Length of Paying Haul.—Before taking up the analysis of the formulas by Messrs. Ford and Bradlee and the Wisconsin Commission, it must be noted that any change in existing fares or fare limits will probably change the riding habit of the public. The road will probably lose some passengers if the fare is raised, and others will ride a shorter total distance rather than pay a second or extra-distance fare.

Assuming a general case, let it be said that a reduction of the average haul per unit fare has been found necessary and that this is to be accomplished by shortening the original unit-fare limits. Now if the average ride per revenue passenger, D_1, after the adjustment, is greater in length than the paying haul, H_1, per original unit fare, the passenger must pay an additional fare assumed to be approximately proportional to his length of ride.

Before the readjustment,

$$R = PU \tag{1}$$

After the readjustment, the new average fare should be made equal to $U\frac{D_1}{H_1}$ in order that the new total revenue shall equal the new total expenses. Therefore,

$$R_1 = P_1 U \frac{D_1}{H_1} \tag{2}$$

Dividing equation (1) by equation (2),

$$\frac{R}{R_1} = \frac{PH_1}{P_1 D_1} \tag{3}$$

and solving for H_1

$$H_1 = \frac{RP_1}{R_1 P} D_1 \tag{4}$$

In equation (4), there are four unknowns: The new number of passengers, P_1; the new average ride, D_1; the new total receipts, R_1; and the paying haul, H_1.

While it might be possible to make, in advance, estimates of the probable total number of passengers, the average length of ride, and the total receipts as they would be after the proposed change, and so predetermine a reasonable length of paying haul, this formula is not offered here for practical application. It is presented only to demonstrate that if a change in number of passengers and passenger-miles is going to occur as a result of readjusting fare limits, then the probable change must be considered in any plan or calculation for readjustment.

It should be noted in the following discussion that none of the proposed formulas takes these probable changes into account.

Ford Formula Reduced to Simplest Terms.—Mr. Ford states that the permissible passenger haul is equal to the cash receipts per passenger divided by the sum of the reasonable fixed charges, fair return on investment and operating expenses per passenger-mile. This is the general statement of the Ford formula. In terms of the notation given above the general formula of Mr. Ford becomes:

$$H_1 = \frac{\frac{R}{P}}{\frac{F_1 + I_1 r_1 + W}{PH}} \tag{5}$$

Performing the indicated division in equation (5) we have,

$$H_1 = \frac{R}{F_1 + I_1 r_1 + W} H \tag{6}$$

but

$$R = F + Ir + W \text{ (very nearly)} \tag{7}$$

whence

$$H_1 = \frac{F + Ir + W}{F_1 + I_1 r_1 + W} H \text{ (very nearly)} \tag{8}$$

The Ford formula, then, is simply the statement that if the number of passenger-miles and the operating expenses remain the same, then to increase the receipts sufficiently to pay the reasonable fixed charges, F_1, the fair return, r_1, on the reasonable investment, I_1, and the operating expenses, W, the average passenger haul per unit fare must be decreased in the same ratio as the total normal expense is increased. But as has been shown above, the assumption that passenger mileage will remain the same is open to question, and moreover the operating expenses may be affected by any change.

Bradlee Formula Reduced to Simplest Terms.—Mr. Bradlee makes his calculations on a car-haul basis without direct reference to average passenger haul. He states that the allowable or paying car haul is equal to the amount of gross receipts available for operating expenses per half round trip, divided by the operating expenses per car-mile.

$$L_1 = \frac{\frac{R - F_1 - I_1 r_1}{2B}}{\frac{W}{N}} \tag{9}$$

By simplifying

$$L_1 = \frac{(R - F_1 - I_1 r_1)}{W} \cdot \frac{N}{2B} \tag{10}$$

But

$$\frac{N}{2B} = L = \text{actual average car haul per half round trip} \tag{11}$$

$$L_1 = \frac{(R - F_1 - I_1 r_1)}{W} L \tag{12}$$

Wisconsin Railroad Commission Formula Reduced to Simplest Terms.—In the Wisconsin Railroad Commission method, the total cost of service is divided up into "readiness-to-serve" costs and "movement" costs. This division is made by classing all costs which go on independently of traffic as readiness-to-serve,[1] and those which are wholly dependent upon the amount of passenger business as movement costs. Certain other expenses are proportioned between the two on the basis of the ratio of average load to comfortable load on the cars. The Wisconsin Commission states that the allowable or paying passenger haul per unit fare is equal to the average receipts minus the terminal

[1] The Wisconsin Commission has designated this as a terminal charge, but in fact it is "readiness-to-serve" rather than "terminal" in character.

cost per revenue passenger divided by the movement cost per passenger-mile.

$$H_1 = \frac{\frac{R}{P} - \frac{T_1}{P}}{\frac{M_1}{PH}} \tag{13}$$

$$H_1 = \frac{(R - T_1)}{M_1} H \tag{14}$$

Discussion of the Several Formulas.—All discussion and criticism of these formulas may be condensed into the single statement that unless the new conditions, after a change in length of haul per unit fare, are such as to make the new gross receipts equal to the new and reasonable gross expenses $(F_1 + I_1 r_1 + W_1)$, the change has failed to accomplish its object.

For any given case the proper use of the above formulas may possibly give a fair preliminary idea of the necessary amount of readjustment of single-fare limits. But the actual changes will be influenced far more by the factors of convenience in operating the railway and the greatest possible satisfaction to the riding public consistent with a reasonable income to the railway.

In the case of the Wisconsin method, the difficulty of deciding what items properly belong with the readiness-to-serve costs, and what items with the movement costs, makes the application of this method rather unsatisfactory. It is also a pertinent question as to whether a readiness-to-serve charge should not be applied twice to the transfer passenger, rather than as an equal charge against each revenue passenger regardless of whether or not he uses more than one car.

Conclusion.—These several formulas, while interesting and instructive from a purely statistical point of view, are not very well adapted to practical application when it comes to an actual case of revising any given fare system either with the object of giving lower fares for short hauls or of increasing revenues by charging more for long hauls. In the three following chapters, there are presented some discussions, providing, in considerable detail, for simple and practical revisions of fare systems upon a basis relating, in some degree at least, to length of haul.

CHAPTER XII

POSSIBLE METHODS OF REVISING FARE SYSTEMS

Four Possible General Methods Suggested.—Granting for the moment that changes in the fare system and rates of fare on many American street railways are desirable, or will soon be so, the next step is to consider the possibilities which are open. It will be understood, in connection with the following discussion, that proposed revisions of fares are to include especial consideration of the length of haul factor, whether the primary object of the fare revision is to increase a company's revenue or to decrease the unit rate of fare. Therefore, straight increases or decreases in the flat rate of fare as at present applied to both very long and very short rides are ruled out for the reasons outlined in Chapters IV and X. The following are the principal methods of revision to be considered.

1. Retain the 5-ct. fare within certain more restricted limits and add one or more cents excess fare for rides beyond these limits, in cases where increased revenues are necessary. A fare system of this nature is now used in Milwaukee, and is described in Chapter VIII.

2. Reduce the initial fare to a lower unit, say 3 or 3½ cts., and limit the single fare area or the length of line to an amount such that the lower unit fare will be profitable. Beyond these limits add extra zones and zone fares.

3. Divide all lines into uniform, or nearly uniform zones or stages of moderate length (the mile being a reasonable and convenient unit) and impose a uniform zone or mileage rate of reasonable amount. Under present-day conditions on the ordinary street railway, this rate should not exceed a maximum of 2 cts. per mile. This plan is now used by British and other foreign street railways. As applied to British systems, it is described in Chapter IX.

4. Impose an excess charge of one or more cents for transfers. While it may not be universally true, it has been found in Boston that the average passenger using a transfer rides farther than the

non-transfer passenger. This plan is now used in Cleveland, in association with 3-ct. fares.

Certain combinations or modifications of these methods are also possible.

Particular System of Fares Must be Determined By Local Conditions.—No one method can be recommended as universally preferable to all the others. Every street railway has its own particular conditions and problems to deal with, and each one must be treated as an individual case, deserving individual study and special provisions for its own peculiar conditions. Each one of the four general systems of fares outlined above has its own particular advantages and disadvantages. They all mean the addition of certain complexities and difficulties in the collection of and accounting for fares, as compared with the present flat-rate system. Such added complexities, however, need not prove insurmountable. The fares on the European tramways very closely approximate mileage rates and are collected without difficulty. The operation of the Milwaukee suburban zone system has now been carried on for more than 2 years in a satisfactory manner. The Shore Line Electric Railway of Connecticut has recently adopted a fare system on its interurban lines which is practically a mileage rate. Many interurban lines in the western part of this country use mileage rates.

While bearing in mind that every individual street railway must be given special consideration, and a fare system adopted which is best fitted for the particular case, the general conclusion may be drawn that for the most desirable city service, a reasonably limited central area should be served for a flat rate of 5 cts. (or less if the central area is not too large and the traffic is sufficiently dense) with free transfers good only within the central area, while the surrounding territory should consist of one or more fairly uniform zones in which a small additional fare for each zone is collected. For lines which are wholly suburban or interurban, something which approximates a mileage rate is desirable.

Any Proposal to Increase Revenues Must Be Subject to Approval by Regulating Commission.—In connection with any proposed revision of fares with respect to length of ride, there is the question of the immediate and future effect of the new rates on the company's revenue. It may be desired to increase the earnings or to leave them practically unchanged. A serious proposal to materially decrease the revenues of many of the street railway companies is scarcely to be considered under present conditions.

When the decision is made to revise any fare system, careful consideration must be given to the company's financial condition, and the future outlook. The additional cost of giving high-grade and adequate service must be estimated if the company is not already furnishing such service. *If the company desires to increase its earnings under the new fare system, it must be prepared to demonstrate the necessity therefor to the proper commission or other public authority.*

If an increase is desired and proved necessary to the satisfaction of the regulating commission, the plan of limiting the haul for the existing flat-rate fare, and charging an extra fare for longer hauls provides the simplest and most expeditious means of getting it with the minimum disturbance to the public.[1] A 10 per cent. increase in gross revenue may be secured by charging 25 per cent. of all passengers an extra 2-ct. fare, and continuing the 5-ct. fare for the benefit of the other 75 per cent. who travel shorter distances. If any traffic loss is to be suffered, it will be among the long riders who are unprofitable at 5-ct. fares, but there is less likelihood of losing many of these as the daily trip to and from the center is too long to walk, and in general they will be a class of people who can best afford to stand the increase.

An increase may be obtained by a judicious application of system 2,[2] to a fairly large city, but it will be harder to arrange satisfactorily for this purpose. For maintaining the revenue at about the same point and more equitably distributing fares among the long and short riders, it is an excellent plan. It contains inherent possibilities for profitable increases in earnings through the stimulation of traffic at lower unit fares for short rides, if the fare limits are properly and fairly located. It is scarcely applicable, however, to cities of a radius of less than 5 miles.

On suburban and interurban lines, system 3[3] may be arranged to give practically unchanged earnings or increased earnings, as may be desired, with the limitation, however, that if any material increase is made in the fares of any considerable group of passengers, traffic losses are apt to offset the expected increases in gross revenues for a few years.

[1] These various methods are described in greater detail in Chapters XIII and XIV.

[2] Lower unit fares for very short hauls. [3] Mileage rates.

Transfer Charges Not Generally Desirable in American Cities.—System 4, involving a transfer charge, is probably the least desirable of all the suggested methods. The results of the traffic study made in 1915, on some of the Boston Elevated Railway Co.'s lines, showed that the average passenger using one transfer took a longer average ride than the non-transfer passenger, while the passengers using two and three transfers to complete their rides took still longer average rides. On the other hand, while this may be true of the average passenger, there are, nevertheless, many passengers who are so situated with respect to the street railway lines, that they are obliged to use one or two transfers even for a very short total length of ride. The transfer system is frequently a benefit to street railway operators in that it permits the most efficient routing of cars without giving direct service between all individual points on the system to suit the needs of small groups of riders. A charge of 1 ct. is made for transfers in Cleveland, Ohio, at the present time in connection with the 3-ct. fare.[1] Between certain lines on the Philadelphia Rapid Transit system, 8-ct. exchange tickets are sold. This is virtually a 3-ct. charge for a transfer. There are certain arguments in favor of transfer charges, such as the reduction of abuses and the charging of the passenger for the extra cost of stopping and starting the second car for him, the double liability of boarding and alighting accidents, etc. These arguments are aside from the main purpose of this discussion. A charge for transfers may be necessary or desirable for particular reasons in specific cases, but in general it will not be considered advisable because of the closer relations which the free transfers give between the passengers' travel needs and the companies' car routing.

Traffic Study a Necessary Preparation For a Distance System of Fares.—Practically any method proposed for the revision of fares to a distance basis will require some form of traffic study, the extent and cost of which will depend chiefly on the method of fare revision proposed and the accuracy of detail which will be necessary to convince the public of the justification for the particular arrangement and location of fare zones. The necessary traffic studies in connection with the systems described herein are outlined in the following chapters.

[1] Most of the transfering is done by passengers riding into the center of the city (Public Square) and changing to an outbound car on another line.

CHAPTER XIII

DETERMINATION OF THE ECONOMIC LIMIT OF HAUL FOR THE SINGLE FARE IN CITY SERVICE, AND PROPER RATES OF FARE FOR LONG HAULS

Several rules or formulas have been suggested by various street railway experts for determining statistically the permissible or "paying" length of haul for the 5-ct. fare. These formulas involve various factors of traffic and cost of service, and the more carefully these various factors are analyzed, the more complicated the formulas become. In Chapter XI, the formulas derived by Mr. Ford, Mr. Bradlee, and the Wisconsin Railroad Commission have been briefly reviewed and criticized.

In presenting and discussing this matter of limiting the haul on street railways to its economic length, it is not intended to imply that all, or even a majority of the companies need curtailments in the single-fare limits, or that they need increased revenue. There are, however, a number of street railways which are not able to meet the increasing expenses of operation and maintenance and pay a fair return on invested capital.

Such was claimed to be the condition of the Bay State Street Railway Co., which has recently had before the Massachusetts Public Service Commission, a proposal for a general advance in fares from 5 to 6 and in some cases 8 cts., all over its system, covering a large number of cities, towns and rural districts in eastern Massachusetts. An increase of 20 per cent. in the fares of the short riders in the cities of Lowell, Lynn, Brockton and other large centers served by the Bay State lines was naturally opposed with much vigor by the people affected and the Commission for various reasons refused to allow the increased rate in the cities.

The Boston Elevated Railway Co. serves a very large area for a 5-ct. fare, but it has recently failed to earn the customary and apparently reasonable dividend of 6 per cent. on its capital stock. Moreover, in various sections of the city, it is not now giving the quality of service which is desirable. It may, perhaps, improve its condition without any changes in fares or fare systems, but the continually increasing burdens of new tunnel and elevated lines and additional transfer privileges give rise to some doubts as to the future possibility of retaining the flat 5-ct. fare unit over the whole of its present 5-ct. territory.

In Cleveland, the operation of the street railway system at 3-ct. fares has been accompanied by substantial annual deficits which have been only partially wiped out by the 1-ct. transfer charge.

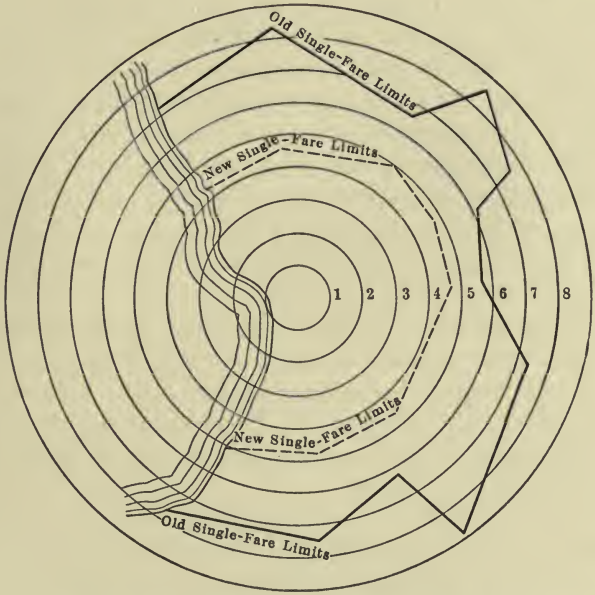

FIG. 57.—Assumed case illustrating determination of economic limit of haul for single fare. Method of determining location of new single-fare limits given in Chapter XIII.

It is to such cases as the three here mentioned that the following discussion is intended to apply, and chiefly to city areas, or lines where the traffic flows to and from a central business district.

Instead of trying to devise a formula which will take into account all of the many factors governing the cost of street railway service, the economic limit of haul and the probable traffic changes which will occur with any change in fares, the following simple and direct method is suggested for limiting the single-fare ride on unprofitable systems to a paying basis and placing the increased fares, if such are necessary, on the long riders. It also provides for the reduction of fares in either the outer or the central area, if revenues become more than sufficient to pay the reasonable expenses and a fair return.

In order to illustrate the details of the method herein proposed, let it be assumed that some existing street railway system is being considered. Suppose, for example, that a company serves an area such as that shown in Fig. 57 for a flat rate of fare, presumably 5 cts. It claims that it is no longer able to provide adequately for its operating expenses (including repairs and renewals) and taxes and to continue the payment of a return to its investors with the revenue derived from its traffic at the 5-ct. rate of fare. It consequently asks for relief in the form of increased fares. Under the present-day conditions of regulation, a company making such a request will be required to prove the truth of its contentions to the public's representatives or regulating commissions or legislative bodies. It will also have to demonstrate that it is operating the system in an economical and efficient manner which is consistent with good service and safety.

Now the public may not have to grant the right to increase fares. The road may be assisted by the remittance of taxes, paving expenses, snow removal and similar burdens. The public may even refuse to grant any relief, in which case poor service and depreciated, obsolete equipment, and the ultimate bankruptcy of the system are the probable results.

The reasonable and probable case, however, is that in which a fair-minded public will be willing to permit any reasonable but not excessive readjustment of rates, provided that good service is rendered in return. The problem is, then, how to curtail the possible length of ride for the existing fare to its economic maximum and to make the necessary increases in fare for longer rides as reasonable and as little burdensome as possible. It has been earlier shown that uniform increases in fare of 1 or 2 cts. all over a system, tend to discourage short riding, reduce the total annual number of passengers and thus considerably offset the expected increase in net revenue. Such a change may, therefore, be equally undesirable for the general public at large and the part of the general public who compose the company.

The first step is to determine as accurately as possible how much additional revenue is necessary to adequately meet all reasonable and proper expenses for good service and to pay a sufficient return on the cash invested to attract new capital when necessary. This problem must be worked out by engineers and expert accountants familiar with railway expenses. The proper parties for such work would be the engineering and accounting staff of a competent public service commission coöperating with the railway's officials, assisted by independent consulting experts in engineering and accounting.

Having determined the additional revenue necessary, the next step is to decide how much the increase in long-distance fares should be, and with a given increase, what per cent. of all the passengers must stand the increase.

Suppose that it has been found that a 10 per cent. increase in gross revenue is necessary to make the road a self-supporting, sound proposition under present conditions. There are then many possible combinations by which this increase may be obtained, varying all the way from charging a very few passengers a large additional fare down to dividing the 10 per cent. addition equally among all of the passengers. Using even cents for the possible additional fare, the following combinations will furnish 10 per cent. additional revenue for the system originally operating at a flat 5-ct. fare.[1]

(*a*) Charge 50 per cent. of the passengers 1 ct. extra, *i.e.*, a 6-ct. fare.
(*b*) Charge 25 per cent. of the passengers 2 cts. extra, *i.e.*, a 7-ct. fare.
(*c*) Charge 16⅔ per cent. of the passengers 3 cts. extra, *i.e.*, a 8-ct. fare.
(*d*) Charge 12½ per cent. of the passengers 4 cts. extra, *i.e.*, a 9-ct. fare.
(*e*) Charge 10 per cent. of the passengers 5 cts. extra, *i.e.*, a 10-ct. fare.

NOTE.—The percentage of passengers required to pay a given addditional fare in order to make up a stated percentage increase in gross revenue, is equal to the existing rate of fare multiplied by the per cent. increase required in gross revenue and divided by the given additional fare. Example: 10 per cent. increase in gross revenue desired, additional fare for long rides to be 2 cts., then percentage of passengers who must pay this excess equals

$$\frac{5 \times 10}{2} = 25 \text{ per cent.}$$

The next step in the process is to select one of the fare combinations which will be best adapted to local conditions and least

[1] Other combinations may be used, such as charging all passengers ½ ct. extra, by selling 10 tickets for 55 cts.—a single money fare being then 6 cts.—but the foregoing combinations involving even cent changes are sufficient for illustration.

likely to arouse public antagonism and consequent loss of traffic. Any considerable loss of traffic upsets the calculations on which the fare increase is based and it is essential to make arrangements which will have the least possible adverse effect.

In the case that has been assumed as an illustration, let it be supposed that in the judgment of the railway officials and the public representatives,[1] it seems advisable to use item (*b*) above, namely, charging 25 per cent. of all the passengers (which should be the long riders) an extra 2 cts. over their regular 5-ct. fare. Then it is only necessary to lay out a new line of 5-ct. fare limits inside the old limits in such a way that an outer area will remain, from which under average conditions 25 per cent. of the railway passengers originate or to which they ride. Moreover, this new line of fare limits may be laid out so as to lie at a fairly *uniform distance* from the central district, unless there are very good reasons for stretching some lines and shortening others.

The determination of the theoretically proper location for this new line of limits is not at all difficult and a simple method is described below. The difficult part of the problem lies in satisfying or overcoming the thousand and one local petitions, arguments and objections that are always offered regarding the exact location of new limits. This trouble is by no means peculiar to the particular method suggested in this paper; it is a characteristic and perfectly natural factor in any and every proposed change of fares or fare limits regardless of the means used in calculating the theoretically correct position. It will frequently be contended, for instance, that because one line has a high traffic density, and consequently low cost per passenger, its single-fare limit should be extended further than that on a line of low traffic density. To adopt this policy means further crowding of population along the already heavily loaded line and the retarding of development along the thinly settled route, and the question then gets into the realm of public policy regarding density of population and housing.

Locating the New Fare Limits.—To locate the theoretical position of the new line of fare limits in accordance with reasoning adopted up to this point, it is necessary to learn the traffic characteristics of each line which operates from the inner portions

[1] It would hardly serve any useful purpose to submit these questions to a popular vote where local interests are so directly affected, at least before details have been carefully worked out by a conference.

of the area to the outer. No particular consideration need be given to intown belt lines or short radial lines which are plainly too limited in length to require any increased fare.

On all lines which extend into any part of the outer territory which might possibly be included in the increased fare zone, some form of traffic count must be made. The simplest and cheapest way to get data which should be accurate enough to serve the purpose of this problem, would be to have the conductors on the cars *read* and *record* their cash registers at every stop, or at least at frequent intervals, on each route concerned, on inbound trips, on several representative week days and Sundays. They should also record the number of passengers leaving the cars at any stop. These observations need be extended only over the outer portions of the route, as there is no advantage in taking them within the area which will surely retain the original fare. On the outer portions of the routes, the conductor of a car is not so busy, and in general he should be able to handle this extra duty for a few days without much trouble. Conductors suspected of carelessness or negligence in making the required observations may be checked up by special inspectors.

If the conductors cannot be given this extra work, special observers may be detailed to ride on the cars and tabulate the number of revenue passengers boarding at each stop, and also the number leaving if this is believed to be an appreciable factor. In the latter case, it may not be necessary to place men on every car, and they will not have to ride in beyond a point where it is certain there will be no change in fare.

The office work will be to total up the observations of passengers boarding cars at each stop, or in designated districts on each route, and find the percentage of each total to the total passenger traffic on the whole system for the particular day of the observations. The results for different days should be compared, so as to judge whether or not a very extended series of observations is necessary to obtain a fair average. Sunday traffic should ordinarily be especially weighted. When a fair average of traffic conditions has been obtained from data of passengers boarding inbound cars, the percentages should be multiplied by 2, to allow for the outbound traffic which will, in general, be very nearly the reverse of the inbound traffic.

The next step is to plot for each line the cumulative percentage of passengers originating and leaving at each stop or designated district. The plot for any particular route might appear somewhat as shown in Fig. 58.

If the observers should count any passengers leaving the car in the early part of the trip, such passengers should be excluded, as they are probably short riders and are not available for higher fares.

The line of fare limits may now be located most easily by a a method of trial. The judgment of the man working on the problem should enable him to make a rough estimate of the probable location of the line. Suppose it is assumed that it will lie about 5 miles from the center of the city. By adding up the percentages, shown at points on each route where the route is cut by the 5-mile circle, the total percentage of all passengers originating from and riding to points outside the 5-mile radius will be obtained. If the sum is less than the predetermined

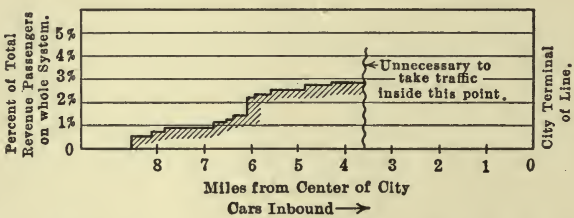

FIG. 58.—Assumed case illustrating determination of the economic limit of haul for single fare. Illustration of traffic distribution on any one route.

requisite (25 per cent. in the example previously used for illustration) it is necessary to try a point nearer the center, say 4½ miles. Only a few trials involving a few minutes' work in the office will be necessary to find the theoretically correct limiting radius.

After having located the theoretically correct fare-limit radius on the percentage route charts, the points may be at once transferred to a map of the system and then located on the ground. It is at this point, however, that a step comes in, which cannot be dealt with on any theoretical basis. The calculated points having been located, it will be essential that the actual fare-limit points be finally located somewhat *nearer* the intown district than indicated by the calculations, for the following reasons:

First.—No matter where the new fare limit is fixed, people living outside the central single-fare zone, but within ¼ to ½ mile of it, will generally walk to and from the fare limit point to save the extra fare, and thus the calculated increase in revenue from these people will be lost.

Second.—Some traffic losses will probably be suffered because of the increased fare. The greater the excess, the greater will be such losses.

Third.—The work of laying out this new system of fare limits is somewhat complicated and expensive, and requires much tactful dealing with public opposition, no matter how justly and carefully the calculations may be made. Therefore, it is best to get the limits sufficiently far in on the first trial, rather than to have to make further curtailments at a later date. It will be easier to grant extensions at any time if the revenues are higher than necessary, than to make new curtailments if revenues are still inadequate. The dotted line, Fig. 57, represents the new line of single-fare limits within the old area.

Possibility of Reduced Unit Fares.—If it is desired to have lower unit fares than the existing 5-ct. rate, it will be imperative to institute something more nearly equivalent to a zone system than the above described reduction of the single-fare area. Unless the street railway company is unusually prosperous, no large reduction in gross revenue can prevail without curtailment of either quality or quantity of service. Therefore, the *average fare per revenue passenger* cannot be much decreased, if at all, which simply means that for every short rider who gets a lower rate than 5 cts., there must be a long rider who pays a correspondingly higher rate than 5 cts.

For instance, if it be desired to secure a 3-ct. fare for short rides, then the first-fare limits must be drawn in much further than indicated in the preceding discussion, and zones must be established along the lines extending beyond the central 3-ct. fare territory in such a way that passengers will pay increasing fares as the length of ride increases. Somewhat more elaborate traffic counts would have to be made to establish the proper limits for the 3-ct. fare area and the various zones in such a way as to ensure the company's revenues against any disastrous reduction. If the reduction of unit fare invites short riders sufficiently so as to largely increase traffic density, as may be possible, it is easy to provide for an extension of the limits when this is accomplished.

These statements are in accordance with the demonstrated facts in Chapters II and III, in which it was shown that low costs of service per passenger came only with high traffic density per car-mile, and that the latter is dependent upon the short haul.

Sliding Scale of Fares to Provide for Exactly Proportioning Revenues to Expenses.—To provide for the possibility that the new arrangements will not give the company substantially the revenue which has been agreed upon as necessary and proper, a provision for a sliding scale of fares or an extension of fare limits may be made. If, for instance, it is found after a reasonable trial, that the gross revenue is still insufficient, allowing for any proper increases or decreases in expenses subsequent to the original agreement, the outer-zone fares may be raised a fraction of a cent, say from 2 cts. to 2½ cts., the fractional unit to be obtained by selling 4 tickets for 10 cts. If, on the other hand, it becomes evident that the railway is making more money than it needs to meet its necessary and proper expenses, any one of three things may be done:

(*a*) The outer territory excess fare may be reduced a fraction of a cent, by sale of tickets.

(*b*) The central district unit fare may be reduced a fraction of a cent, by sale of tickets.

(*c*) The central district unit-fare limits may be extended further into the outer territory.

The specific figures for revenue, fares and distances, quoted throughout the preceding pages of this discussion, are introduced only to illustrate the process of reasoning, as it is easier for the reader to follow the trend of thought with familiar units and figures, rather than with abstract symbols. The whole method, however, is perfectly general.[1]

It is believed that the method proposed herein is an improvement on any of the heretofore proposed formulas for the following reasons:

1. It provides for a reasonable equalization, if desired, of the length or radius of the unit-fare haul in previously irregular single-fare areas. On the other hand, the new and limited single-fare area may be left irregular if special circumstances warrant so doing.

2. It provides, not only a direct and logical method of calculating the economic limit of haul for the unit fare, whatever that unit may be, but it also includes a reasonably accurate determination of what additional fares and fare limits should be established for long riders, an important point which does not appear to have been touched on by the other so-called formulas.

[1] Except for the original limitation, that it is designed for city areas and not interurban roads.

3. It makes use of no questionable "average" costs per car-mile or per passenger-mile which may differ greatly on different parts of the same system, nor does it require any laborious and possibly arbitrary methods of cost analysis, but it relies upon classifying the riders according to the lengths of their rides.

4. If the general method of simply reducing the single fare area for the existing unit fare is used, the expense and trouble of a traffic count is required only on the outer parts of the long lines, and not over the whole area, as is the case with formulas using the passenger-mile cost unit.

The Collection of Fares Under the New System.—No insurmountable difficulties in regard to fare collection need be anticipated in connection with a revision of fares as outlined in this chapter. Experience with the zone system in Milwaukee for the past 3 years and the rapid spread of fare box and prepayment systems all over the country has demonstrated the facility with which new methods of fare collection can be handled in practice.

As the prepayment system of collection has become so prevalent in recent years in city service, because of its speed, convenience and certainty of collection, it is desirable that it be retained as completely as possible under any new system of fares. With the systems outlined in this chapter, there is no reason why the present methods of prepayment of fares and free transfer arrangements cannot be continued without change in the central unit-fare district, no matter of what size the district may be, but if tickets or other than nickel fares are used, some of the self-recording fare boxes may possibly have to be changed to locked boxes.

A general scheme of fare collection which should meet almost any ordinary conditions is suggested below. It may be said, however, that every individual street railway has its own local conditions and peculiarities to deal with and proper plans can best be devised by local men, using the general methods suggested in this report as guides which may be modified in any reasonable way that may seem desirable.

Fare Collection in Central Fare Area.—Retain prepayment system, with usual free transfer privileges. Every passenger boarding any car in any direction pays his unit fare, whether a nickel, 3 cts., or a ticket, on entering the car (or at prepayment stations if such exist). Transfers to be issued and accepted at proper points as at present.

FARE COLLECTION IN OUTER ZONE TERRITORY

On Inbound Cars.—Fares to be paid for whole trip as passengers enter cars. Conductors issue distinctly colored or punched receipts showing to what zone each passenger has paid. Receipts to be surrendered by passengers on leaving the cars. Motormen can see to surrender of receipts if passengers leave by forward door. If a passenger does not have proper receipt for the zone to which he has ridden, conductor will collect the balance of fare.

On Outbound Cars.—Use "pay-leave" system. The great majority of passengers will have ridden through from the central district, in which they paid only their initial unit fare. On the outbound car, in zone-fare territory, the passenger leaving the car will then be charged for as many zones as the car is distant from the central area. If any passenger is not a "through" passenger, he will have boarded the outbound car in some one of the outer zones. Such passengers should have their fares collected when they board the car and should be given a special receipt to be surrendered on leaving in lieu of the fares collected on the pay-leave system. The last provision will be unnecessary if there are only one or two zones outside the central area.

Ticket Systems.—Where unit fares or zone fares are less than an even 5 cts., it is frequently desirable to have tickets sold in strips or books, with some moderate number for a reasonable unit payment. Such ticket systems are, for instance, the 6-for-a-quarter system in Washington, D. C., the 5-for-15-ct. system in Cleveland, and the 30-zone-tickets-for-50-ct. system in Milwaukee suburbs.

Tickets sold in this way greatly reduce the labor and the delay which fall to the lot of the conductor if he has to make penny change for a large number of passengers. They are convenient also for the passenger, and if the initial payment for a set of tickets is not too great, say 25 or 50 cts. at a maximum, it will not be a hardship for any regular rider to purchase them.

CHAPTER XIV

A SYSTEM OF SHORT ZONES AND LOW ZONE FARES APPROXIMATING MILEAGE RATES FOR SUBURBAN AND INTERURBAN LINES

Development of the 5-ct. Zone System Outside of City Service.—While there are certain factors in the use of the flat 5-ct. fare for city areas which have made it especially desirable and convenient, and which make any proposal to change over to the zone system the subject of much well-meant opposition, there are fewer important factors in favor of 5-ct. fares for suburban, interurban and rural lines beyond the limits of the single-fare area of a city. The earliest types of these suburban lines were probably extensions of city lines into developing adjacent territory, and it is not strange that the plan of charging a second 5-ct. fare on such lines was adopted. Later on more additions were made to these already extended lines, and more 5-ct. zones were added which, of course, became of greatly varying lengths.

In addition to the adding of irregular 5-ct. zones to city lines by extending trackage further out into the suburbs, there came the period of the development of interurban lines. Many street railways were constructed to connect two or more towns or communities, and, in order to do this, many miles of sparsely settled territory had to be crossed. At first, such interurban lines were short, and one or two 5-ct. zones sufficed to establish the fare system of the railway. The final step bringing us down to the present day was the building of great systems, both by the construction of new and long lines and by the consolidation and physical connection of existing lines.

The result of this process of development has been to leave us a great network of fairly well-organized and usually efficiently managed street railway lines, on which exists a most archaic set of fare regulations. In the majority of cases, the 5-ct. fare limits are practically the same as they were on the original lines. In one place, a 5-ct. fare may pay for a 5- or 6-mile ride and in another place, sometimes in the very next zone, the limit may be only 2 miles. Moreover, if one boards the car a mile or so on one side of some historic fare point, and rides through a 2-mile zone and beyond to a point about a mile on the other side, this 4- or 5-mile ride costs him 15 cts., or more than 3 cts. per mile. In order to pacify public dissatisfaction over such injustice, some street railways have instituted a system of "overlaps" at the existing fare points, which grant certain privileges to passengers whose rides carry them to or from points just beyond the fixed fare points. Such overlaps, of course, will partially ameliorate the gross injustice of paying an extra 5-ct. fare for a very short ride, but they do not remedy the fundamental injustice and irregularity of the 5-ct. zone.[1]

In cases where a suburban street railway finds itself in need of greater revenue than it is obtaining from the existing rates, it has generally been the custom to merely raise the rate from 5 to 6 cts., leaving the same uneven and unsystematic distribution of the fare limit points along the several existing lines. There have been a number of such cases in Massachusetts, and something of the unfavorable result on passenger traffic has been set forth in Chapter IV.

Conditions of Traffic on Steam Railroads are Similar.—After all, the traffic on the suburban and interurban lines is more nearly like that on the steam railroads than it is like the city street railway traffic. On the first mentioned, stops are somewhat more frequent, the average speed is slower, and the frequency of service is usually greater because smaller units are operated, otherwise there is essentially little or no difference in the nature of the passenger service of these railways and some of the suburban service of steam roads.

On the steam railroads, however, the fare system is based on a mileage rate. It is true, of course, that this rate has been more or less arbitrarily fixed in the past at 2 cts. per mile by public authority or long-standing custom, with little or no regard to the actual average cost of service, but recent changes in interstate rates sanctioned by the Interstate Commerce Commission and in intrastate rates sanctioned by various State legislatures and commissions lead to the belief that more weight will be given in

[1] For a criticism of 5-ct. zones and overlaps, and recommendation for mileage rates, for suburban and interurban lines, see "Opinions and Decisions of the Railroad Commission of Wisconsin," vol. 13, p. 482.

future to a reasonable consideration of cost of service. It is also true that on the steam railroads, special reduced rates are made for commutation tickets, multiple-trip and round-trip tickets, but practically always these reduced rates are still proportionate, among rates of their own class, to the length of trip involved.

Mileage Rates on Electric Railways.—In the middle and far West there are a number of modern high-speed interurban railways, operating for the most part on private right-of-way with fixed station stops. These roads, being comparatively new, and being in many senses, except motive power, analogous to steam roads, their fare problem was relatively simple and has been definitely solved by the mileage system of rates. Among the older street railways on which the irregular 5-ct. zone system has long been in vogue, any radical change is more difficult to bring about.

The two most notable examples of street railways which have made the change are the Shore Line Railway of Connecticut, and the suburban and interurban lines of the Milwaukee Light, Heat and Traction Co. The system in effect on the Shore Line Railway entails an average rate of about 1.8 cts. per mile, but the actual zones are a trifle over 1 mile each, a 2-ct. fare per zone being charged. A minimum fare of 5 cts., good for a ride in one or two zones, is in force.[1] The fares on the Milwaukee interurban lines are computed on a mileage basis, 2 cts. per mile, with 1 ct. for fractions of a mile under ½ mile. A minimum fare of 5 cts. is charged for a short ride up to 2½ miles. Mileage books are sold at $5.40 for 300 miles, or 1.8 cts. per mile. In using mileage books, the minimum amount lifted is 5 miles.[2] The special application of this system to the suburban lines just outside of the city of Milwaukee was described at length by Mr. R. B. Stearns, Vice-President of the Milwaukee Electric Railway and Light Co., in a paper published in the annual proceedings of the American Electric Railway Association, 1914, and abstracted in the *Electric Railway Journal*, Oct. 24, 1914.

Advantages of a Distance Basis of Fares Approximating a Mileage Rate.—The chief advantages of a mileage rate on suburban and interurban lines, or something closely approximating a mileage rate, may be summed up as follows:

[1] Described in detail in *Electric Railway Journal*, Sept. 11, 1915.

[2] Described in detail in Opinions and Decisions of Wisconsin Railroad Commission, vol. 13, pp. 475–517.

1. Unequal zone lengths at 5-ct. fares are done away with.

2. A ride which just crosses a fare limit no longer costs an extra 5 cts.

3. When it becomes necessary to increase rates in order to secure a more adequate revenue, a trifling increase in the mileage rate will distribute the added burden more equitably among all passengers, than the old and plainly unsatisfactory method of replacing 5-ct. fares with 6-ct. units. With the mileage system, as practically applied in the two specific cases cited, many rides of moderate length are still available for the 5-ct. minimum fare.

4. Commutation, multiple-trip tickets, special round-trip rates, and special "through" rates between important traffic centers may still be applied, just as in steam railroad practice.

5. Stops being relatively few in this form of street railway service, no particular difficulty will be experienced in devising methods of fare collection which can be readily handled by the conductor. The elimination of "overlap" zones at fare points will simplify the conductors' responsibilities. A method which should cover almost any case would be to have a pay-enter system of fare collection, with a distinctly colored or punched receipt given indicating the point to which fare has been paid. This receipt should be collected as the passenger leaves the car, so that the conductor can readily tell if the passenger has paid the proper fare.

Determination of Proper Mileage or Zone Fares.—In the case of suburban and interurban lines, the fixing of the proper rate of fare and fare limits is comparatively simple. Presumably the mile will be the unit of zone length adopted, as it is a familiar and convenient unit of length, understood by all, but there is no reason why any other unit of distance should not be used.

A simple traffic count should be made, preferably on all trips for at least one whole day. The number of passengers boarding and leaving at each stop should be recorded and totalled for the day. A traffic chart representing the cumulative total for the day should be prepared showing the numbers boarding and leaving at each stop and the total load on the cars between each stop. The total passenger miles for the day are readily determined from the plot by multiplying the total area under the curve expressed in square inches by the proper scale. If possible, this work should be repeated for several days, and the results compared in order to be sure that the data secured were representative of average conditions, and not in any way abnormal. As soon as a normal day's traffic has been determined and the total passenger mileage of that day computed, the approximate rate per passenger-mile can be found by dividing the day's receipts by the passenger-miles.

In case the necessity of increased revenue has been proved, and the amount has been agreed upon, the approximate mileage rate as found above, should be increased by the percentage increase needed in gross revenue.

The next step is to lay out mile zones on a map of the road, noting how and where they affect important traffic points, and modifying the exact location of points in whatever way may seem desirable to men familiar with the local traffic. The points as finally located on the map are next transferred back to the traffic chart and the probable revenue from each zone calculated on the basis of the mileage rate previously determined, and making some allowances for the probability that many passengers will frequently walk a moderate distance, say ¼ mile on either end of their trip, if an extra zone fare can thus be saved. Where this factor would be important can be easily discerned by an inspection of the "passengers boarding" and "passengers leaving" ordinates on the traffic chart. If any considerable allowance is to be made for this rather uncertain factor, it will be found on recomputation that the average rate per mile will have to be slightly increased above the previously figured approximate amount, in order to return the desired gross revenue.

Mileage books may be sold at a price to make each individual coupon worth approximately the finally settled rate, while cash fares should be made slightly higher in order to encourage passengers to use the mileage books. The size and price of the mileage book should be small enough to keep it within the reach of the ordinary workingman, preferably not over one dollar.

No particular rates can be suggested here, because the proper rate will depend largely on density of traffic as demonstrated in Chapter II, and to some extent on operating conditions, prices and wages in the particular locality, and other factors of minor importance.

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