

A STUDY
OF
THE OPERATING EFFICIENCY
OF
THE STREET RAILWAYS OF TENNESSEE

By

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INTRODUCTION

A study of the operating efficiency of street railways, because of the general nature of the subject, becomes of vital interest to every individual of the community served. Every person at some time or other has occasion to use the street car, and the street railway is, in truth, a public servant; hence everyone is interested in knowing whether he is getting the maximum amount of service for the minimum fare paid.

There is a general misunderstanding on the part of the car riders as to what becomes of the fares paid in by them, which is probably due to a lack of information on the subject. This lack of information sometimes leads to very poor relations between the public utility and the public served, which often results in serious detriment both to the public and to the investors in public service property. The treatise which follows deals with:

1. The revenue paid in by the public.
2. The expenditures incurred by the company in rendering service.
3. The return to the investor, or the interest on the investment of property dedicated to public use.
4. The standard of service which may be rendered by an equitable distribution of the above three factors, which is the most important consideration.

Operation being a practical proposition, a study of efficiency becomes relative and hence a comparison of the operations of companies over a period of years is necessary in order to determine efficiency. No statistics have ever been brought together showing these relations and it has been made possible through the financial and engineering reports on file with the Public Utilities Commission of Tennessee, together with traffic surveys of the companies analyzed, and by the procuring of such additional information as to the prices of materials and wages, and other general economic studies applying to the country as a whole.

STANDARD OF SERVICE

"In a general sense, street railway service can be said to have two phases: first, to transport passengers; and second, its aid in the development of the community."*

Inasmuch as the phase concerning development of the community is intangible and impossible of definite standardization, and exerts its influence in financial returns in terms of revenue passengers, it is deemed advisable to base all analysis on actual transportation units. The problem of development of the community as related to street railway operation lies almost wholly within the province of the traffic survey.

A study of pure transportation necessitates a unit in order that direct comparison may be made. No one unit for measuring service in all its phases has as yet been devised. Inasmuch as this thesis will deal entirely with pure transportation, a unit will be used which is a

UNIT OF TRANSPORTATION

"Street railway transportation means that a rider will be carried on a car from one point to another for a money consideration, all of which implies a car, distance, and money. The unit car-mile per revenue passenger involves all these factors and a direct measurement of direct personal service the pay-passenger gets for his money."*

There is a practical question involved in the administration and distribution of service as to whether revenue and cost of service should determine the amount of service given, or whether it should be fixed solely by public demand.

Thus we see two ways of determining a standard of service:

1. Service shall be determined by the existing fare, or
2. The Public shall determine the standard of service and the fare shall be made adequate to meet the cost of such service.

*Ross W. Harris.

OPERATING EFFICIENCY

It is seen that the prime function of a street railway system is transportation.

Let it be assumed that every car operated carries at all times its full normal capacity of pay passengers, i.e. its full seating capacity. Let it also be assumed that every prospective car-rider finds at his command a car for his immediate use.

On the above assumptions, from the standpoint of revenue and service to the car-rider, we would have perfect operation which might be called one hundred percent efficiency on this basis. The assumed conditions being obviously idealistic and impossible of realization, it becomes necessary for practical purposes to use a standard of operation predicated on the ideal, but modified to meet the conditions of normal practical operation.

Mr. Ross W. Harris has designed a method for fixing such a standard, viz:

An estimate of future revenue for a term, say a year, is made, based upon previous experience of the company. From this total revenue is deducted the amount necessary to cover returns, renewals and replacements, maintenance, a small profit and loss account, and taxes. The amount left is available for service. From the prevailing rate of cost of service, the amount of mileage possible is readily determined. Monthly, weekly, and daily mileage required being known, an equitable allocation of money may be made. From the resulting daily allotment, the distribution to various lines and routes may be made according to individual necessity, as determined. From the yearly estimate, a daily estimate per route may now be developed. The mileage required to maintain "readiness to serve" service is deducted from this route mileage and the remainder is distributed along the line according to the length of ride and the number of passengers passing the point of maximum loading.

A satisfactory schedule design will immediately permit an approach to the ideally efficient operation.

THE NORMAL YEAR AS A BASIS FOR COMPARISONS

The wide variations of prices and costs since 1913, and the almost absurd relations existing between actual book accounts of a corporation and the inflated values due to the extreme conditions prevalent since 1913, makes it necessary to go back to a "normal" year for a basis of comparison.

The mass of writers and statisticians dealing with subjects of this general nature seem to agree upon the year 1913 as such a normal year and, accordingly, statisticians have reduced all prices prior to or since 1913 to index figures, using the price prevailing in 1913 as a base and have related prices prior to or since 1913 to this base expressing the result on a percentage basis, which percentage is called an index figure. For example, a price of \$1.50 per unit in 1913 would be taken as unity; if the price of the same commodity was \$2.50 per unit in 1918, the 1918 price relative to 1913 and expressed in percentage 2.50 divided by 1.50 or 166.6%. Curves have been published showing the monthly fluctuation of prices as compared to 1913 index. (See sheet 2d).

Because all available comparative data has been reduced to 1913 index, the study covers a period of ten years beginning with 1913, thus showing the wide variation of cost factors over the war period.

RIDING HABIT

Operating efficiency has been defined as maximum amount of service for minimum fare paid. The volume of business is indicated directly by the number of revenue passengers carried, and the number of revenue passengers per capita per annum will give a direct index as to the extent to which the public uses the street cars. Such data is called the Riding Habit.

The riding habit of the cities studied is shown on Curve Sheet 1. From an inspection of these curves, it can readily be seen that the riding habits of different cities are not tending to follow a general law, but are influenced by various factors, viz: layout of city, distribution of population, type of city, whether manufacturing or residential and jobbing, etc.

However, the year 1915 is noted as being one in which the riding habit slumps in all cases. This was "jitney" year and its effect is seen at a glance.

The changes in the economic conditions of recent date have been far-reaching and have caused a marked decrease in the purchasing power of the dollar and increase in the cost of labor and material. (See Sheet 2). In the street railway business, materials and wages have increased by large margins, while fare rates have not followed with corresponding increases.

The car rider being called upon usually at least once a day to buy a ride and to accept the service as given has the opportunity of immediately discerning any change in service standard. That such changes do exist, yet are not objected to, by a falling off in Riding Habit, may be seen by comparing curve 3 with 1.

The four street railway systems show a regular decrease in car miles per revenue passenger after 1915 and until 1922. This, being the standard of service, denotes a lowering in service rendered. The riding habit shows no such variation. It must be a fact that the riding public would rather have poorer service at a low fare than the service which would result from an increased fare.

The reason for the forced lowering of the service standard is evident from a study of Curve Sheet 2. While street railway fares for Tennessee reached in 1922, a high point of 138% (1913 Index) an increase of approximately two-fifths over 1913, the cost of materials, construction costs, and commodity prices as well as fares for the country reach an average high point of 180% or an increase of about four-fifths over 1913.

From the same sheet in curve number 4, the platform wages for the state show a level always slightly above fares.

METHODS OF ANALYSIS

The figures used in this work are not the ordinary average obtained by adding several factors and dividing by the number of factors used. The result of such procedure would not constitute a comparative unit. The weighted average has been used in all cases pertaining to more than one city.

A comparative example may be given to point out the essential difference between the normal average and the weighted average. Let us take the case of platform wages. Suppose that two systems, one employs 150 men at \$0.50 per hourly maximum wage. The other employs 100 men at \$0.20 per hourly maximum wage. The weighted average is deducted as follows:

$$150 \times .50 = 75.00$$

$$100 \times .20 = 20.00$$

$$\$75.00 \div \$20.00 = \$95.00$$

$$150 \div 100 = 250 \text{ men}$$

$$\text{The weighted average wage is } \frac{\$95.00}{200} = \$0.375.$$

This takes into consideration the number of men employed while the normal average applying to wages only would be $\frac{\$0.50 \div \$0.20}{2} = \$0.35$, a variation of 8% from the weighted average.

All curves based on 1913 index were plotted on semi-logarithmic paper, i.e. the horizontal scale lines are spaced in proportion to the logarithms of the scale figures while the vertical scale lines are normal. The advantage of such a scale is that equal vertical distances anywhere on the chart show an equal percentage rise or fall no matter what the scale figures are. For instance, each vertical inch shows a change of approximately 26.3%.

The distribution of fare is shown clearly on sheet 4. In this sheet the fare is indicated by the circle and the distribution is shown by the segments which are proportional to the percentage distribution. The same data as shown on sheets 8, 9, 10, but in a more easily distinguishable form. The size of the segment was determined as follows: The percentage of each detail to the fare was de-

terminated from data shown with the sheet. 360 degrees divided by 100% equals 3.6 degrees for each percent. Multiplying the percentage figure corresponding to the detail in question by 3.6 degrees gives the number of degrees to plot for showing the special detail in question.

Inasmuch as the existing fare in 1913 was lower than that in 1922 for all cities studied and the fare rate in 1922 was not equal for all cities, this percentage distribution is not a clear index to actual monetary utilization of the fare. The reason for this statement is seen clearly in an example: For 1913 an expenditure of 10% for any item would mean in actual cash, 10% of 5 cents, or 0.5 of a cent. The same 10% in 1922 for Memphis or Nashville would be 10% of 7 cents, or 0.7 of a cent, a discrepancy of 0.2 of a cent, while for Knoxville the same 10% would be 10% of 6 cents or 0.6 of a cent, a discrepancy of only 0.1 of a cent over 1913, but a variation of 50% of the Memphis and Nashville discrepancy. To eliminate the possibility of error, all divisions of fare were reduced to actual money units and these are shown just outside the circle and adjacent to its corresponding segment.

Sheets 5 to 13 inclusive are cumulative curves showing the details of operation built up in logical sequence, i. e. taking the item, "Power", the curve showing "Power" is plotted and drawn. Then the item "Maintenance" is added to the previous item and plotted, thus showing the details separately or as a whole, as one may wish to study them. The smallest item being plotted first and each succeeding larger item being added in turn eliminates to a great extent the overlapping of curves.

Curves 14 to 19 inclusive are cumulative, but have for an upper limit "Operating Expenses" and "Operating Revenue" respectively. All data contained in these curves is expressed as a percentage of a major item.

VOLUME OF BUSINESS AS RELATED TO SERVICE

Curve sheets 20-21-22 show the relation of car miles to Revenue Passenger for the individual cities. An inspection of the curves "Car Miles" and "Revenue Passengers" for Knoxville shows that while the volume of business increases markedly, the number of car miles remains reasonably constant, the result being limited service as shown by the decrease in the curve "Car Miles per Revenue Passengers".

For Nashville, the same condition prevails until 1920, when the volume of business shows a rather decided drop due to the increased fare. Such decrease of business shows that the Nashville riders prefer low service standard to a high fare. "Car Miles" for Nashville shows a tendency to follow the trend of Riding Habit after 1921, indicating better operating efficiency as per definition.

Memphis service in 1915 (jitney year) was not curtailed because of the drop in volume of business as indicated by the increase of car miles per revenue passenger. However, Memphis "Car Miles" follows more closely the volume of business than either Nashville or Knoxville.

OPERATING EXPENSES

Inasmuch as the service standard is determined by the cost of operation, it becomes necessary to separate the operating expense of the street railway companies into their component parts.

Operating expense as defined by the Interstate Commerce Commission means such expenses as are necessary to the maintenance and operation of the property used in transportation service (including service incident thereto), the rendering of service and the collection of revenues thereof.

Operating expenses are divided into four items, viz:

Power which includes superintendence, buildings, equipment, transmission, employees, etc.

Maintenance which includes ways and structures, equipment, track work, ties, rails, keeping track up to date, distribution, cars, shop equipment, etc.

Traffic and General which includes advertising, parks, salaries and general clerks, law expenses, injuries and damages expenses, etc.

Conducting transportation which includes superintendence, platform wages, station expenses, and all expenses connected with the operation of cars.

Owing to the diversity of methods of accounting prior to 1922, these divisions were not carried in the auditor's reports as such. Many difficulties were encountered in the original collection of data because of this lack of uniformity. However, in all cases where items were entered otherwise than according to the I. C. C. definitions, they were placed in proper account before entering on general data sheets as shown in the appendix. (All calculations were made with a Monroe Calculating Machine and a check made in all cases.)

RESERVE FOR RENEWAL & REPLACEMENTS AND INJURIES & DAMAGES

The item "Renewal & Replacements Reserve" is not carried as an operating expense because, no matter what the variation in cost of materials, wages, etc., the depreciation of the tangible property continues. Prior to 1922, the amount of depreciation allowed as a percentage of capitalization was optional with individual companies. A glance at sheet 23 will at once show that this item was not carried in a regular manner, more often than not being entered at the end of the fiscal year as made necessary by the actual payments accrued during the year.

John S. Fletcher, C.E., says, in his "Guide for Investors", Chapter III: "Depreciation is the slow death of physical and other property units....." We have depreciation with us always. It must be considered in a practical way. Practical methods are the simplest and best." The simplest method for determination of annual depreciation for any property is "The Straight Line Method" which is simply this: If a construction unit has a life of twenty years, then one-twentieth of the unit cost is lost each year. Thus by charging off one-twentieth of the original cost each year, we have at the end of the estimated life of the unit, a reserve for replacement. (Fig. A, Sheet 24)

There are two alternate methods of apportioning the yearly depreciation (Fig. B & C. Sheet 24). Fig. B shows the depreciation rapid at first, then more slowly. This method is used for such property as automobiles, etc. Fig. C. shows a slow depreciation in the beginning, then rapid decay toward the end of the term. This method is used in the case of real estate improvements, buildings, etc.

The wide variation of Renewals and Replacements Reserves and Payments for all cities as indicated on sheet 23 shows that money which should have been held in reserve was expended as dividends or otherwise, this amounting to the task of trying to "eat the cake and keep it too".

The matter of Injuries and Damages Accrual shows a more regular movement. However, this account shows an increase over 1913 consistent with the increased volume of business.

PASSENGER REVENUE, OPERATING REVENUE, AND TOTAL COST OF SERVICE

Sheets 25, 26 and 27 show the relations of cost of service to the revenue for each city individually.

The total cost of service is the sum of Power, Maintenance, Traffic and General, Conducting Transportation, R. & R. Accrual, and Taxes.

Passenger Revenue is actual fare totals.

Operating Revenue is the sum of Passenger Revenue and revenue from chartered cars, mail service, car cards, etc.

The difference of Operating Revenue and Total Cost of Service will be the money available for dividends, interest and improvements, consisting of capital investments from surplus.

Sheet 25 shows a regular maintaining of operating costs below revenue with the margin about equal in all cases, even in 1915, the hardest year from the operators' viewpoint. This consistent adjustment of operating cost to the conditions imposed by Riding Habit indicates good operation.

Looking at Sheet 27 the same conditions of operation prevailing until 1919 are seen when the total cost of service shows a rapid rise, while the operating revenue (which is for the most part passenger revenue) does not increase as rapidly as should be expected in order to maintain a good operating efficiency.

Referring to sheet 7, curve 4 shows a decided increase from 1914 to 1922. This is due to the increase in platform wages shown increasing in Sheet 28. The drop of riding habit for Knoxville is compensated by the increased fare of 1921 as shown on sheet 10.

Sheet 6, Curve 4, shows the Total Cost of Service reaching a high point in 1920 when the fare was increasing from five cents to six cents (See Sheet 9) and an equity between Cost and Revenue is reached by a reduction of Wages and Accrual until in 1922, the Operating Revenue again reaches its point above Cost.

Sheet 5 shows operating expense well below cost. A reference to Sheet 29 will show a lagging of wages for Memphis as compared with the other cities.

PERCENTAGE OF DETAILED OPERATING EXPENSES TO TOTAL

Sheets 14, 15 and 16 show only Operating Expenses divided into details as follows: Power, Maintenance, Traffic and General, and Conducting Transportation. These subdivisions are expressed as a percentage of total operating expenses and indicate a general tendency to hold the details of such expenses at practically a consistent percentage of the total.

RELATION OF COST OF SERVICE TO REVENUE

Sheets 17, 18 and 19 in conjunction with sheets 14, 15 and 16 indicate that while operating details are distributed uniformly as a percentage of total operating expenses, the distribution as a percentage of Revenue shows a slowly closing gap for Knoxville until 1921 when, despite an increased fare, lower service standard, and a comparatively good riding habit, the operating cost as a percentage of revenue becomes over 100%, indicating a deficit. The same condition prevails in 1922. Likewise, a deficit is shown on the Nashville sheet for the years 1920 and 1921. Sheet 9 shows the passenger revenue per revenue passenger to be approximately $5\frac{1}{2}\phi$ in 1920 and $6\frac{3}{4}\phi$ in 1921, which means that the fare was raised from 5ϕ to 6ϕ about June, 1920 and from 6ϕ to 7ϕ about March, 1921, showing that the Nashville operators discovered early in the year 1920 that the 5ϕ fare could not provide for the cost of service. In this year the cost of service ran up to 116% of the operating revenue. In 1921 it dropped to 105% and by good regulation in 1922 dropped to 94%.

MEASURE OF SERVICE

Sheet 3 shows the measure of service for the four cities, Memphis, Nashville, Chattanooga and Knoxville. Being arranged as they are, a direct comparison of each city with the others is made possible as well as a yearly comparison of each city as to the general trend.

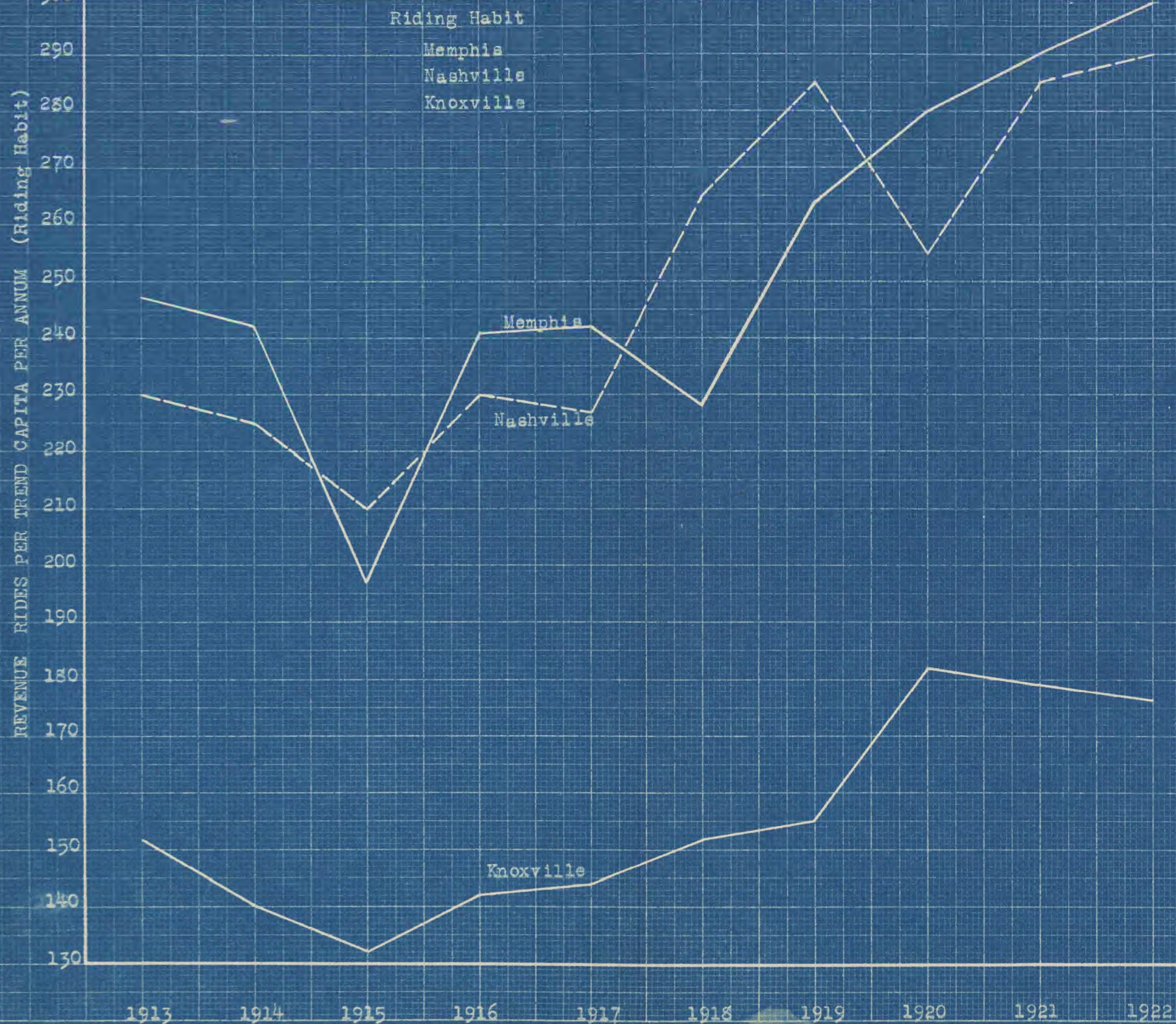
Knoxville shows the most service until 1915 ("Jitney" year) when Memphis forges to the lead. (This condition was noted in Curve Sheet 20). However, Memphis remains in the lead for only one year and the majority of time, Memphis and Nashville show a decrease commensurate with the observed riding habit and Knoxville lags behind the riding habit indications. The years after 1917 show a decided decrease in service, continuing through the period of general business depression (1921). On the whole the decrease of service standard is seen as a general result of the increased cost of service.

CRITERION OF OPERATING EFFICIENCY

On Sheet 30 are shown comparative curves of Passenger Revenue, Operating Expenses, Net Passenger Revenue, and Operating Rates for Memphis, Nashville and Knoxville. The first three terms require no explanation. The fourth term, the ratio of operating expense to operating revenue, decreases or remains constant with good operation, other things being equal.

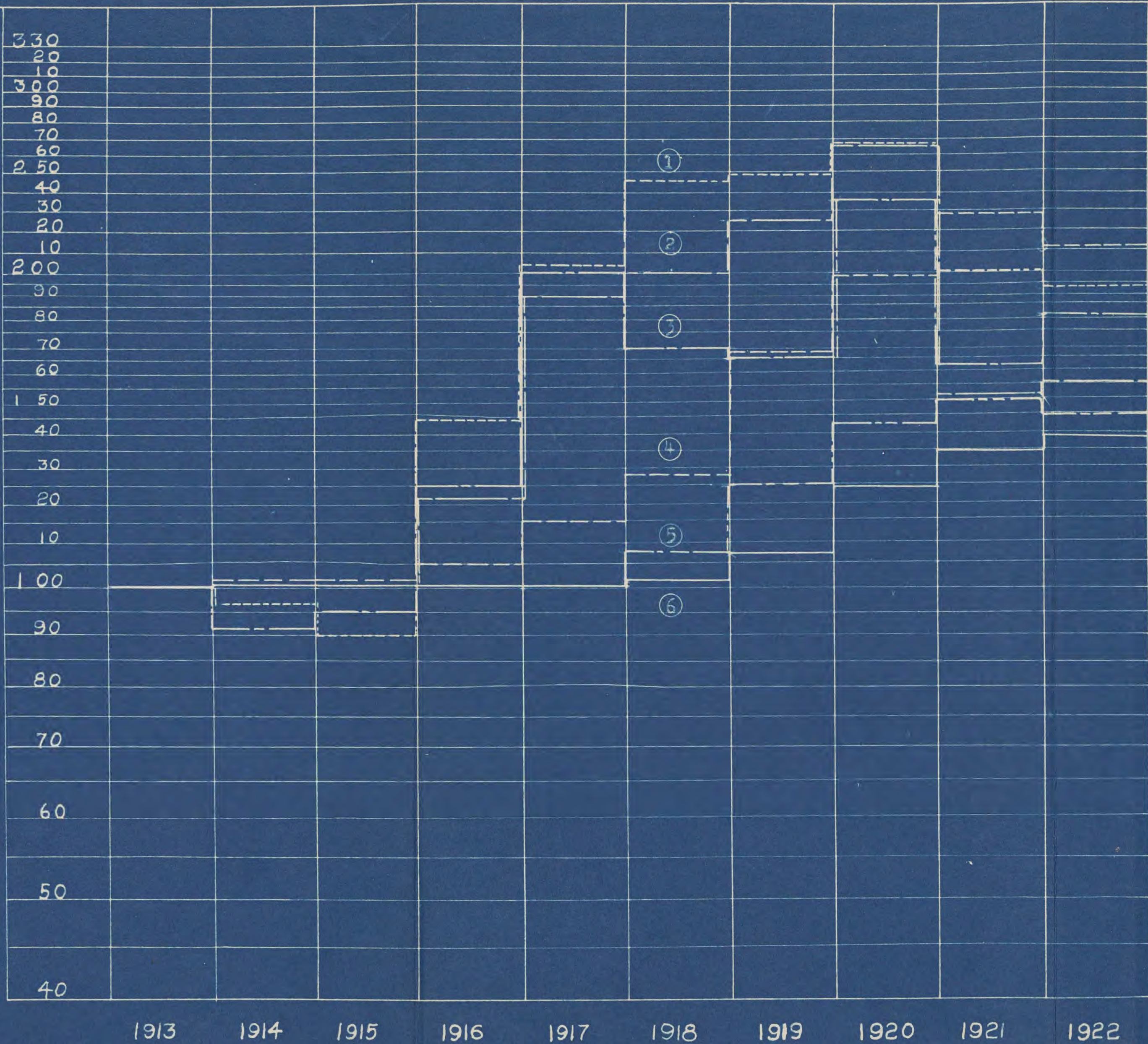
The Curve IV showing this ratio will immediately give a general conspectus of operation over any period. Thus 1919, 1920 and 1921, being high points on these curves, show increased cost without corresponding increase in operating revenue. Such conditions must mean a reduction of some item, either service, dividends, or both.

STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE



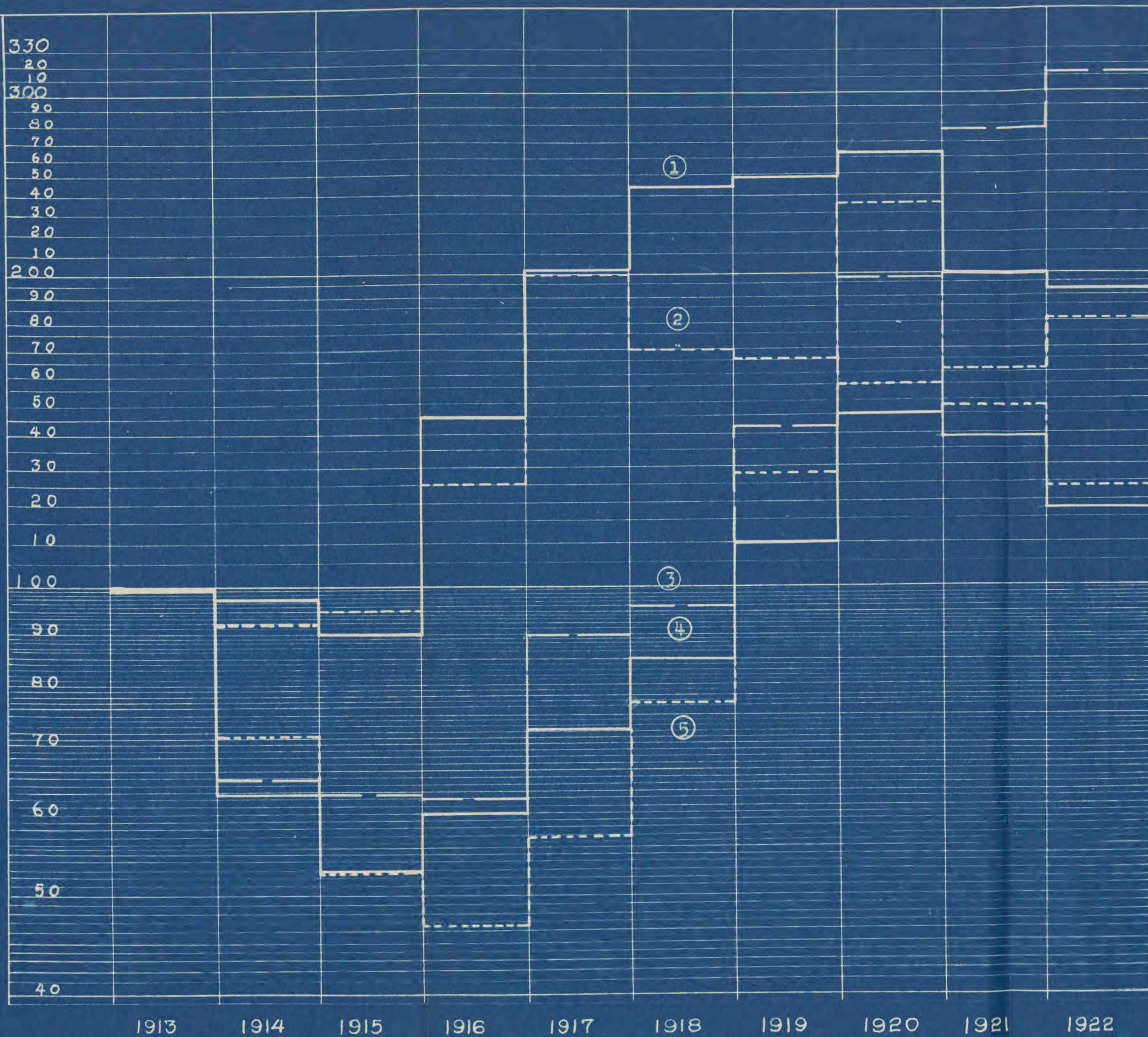
STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE

1. Construction Costs (Engineering News Record)
2. Commodity Prices (U.S. Bureau of Labor Statistics)
3. Street Railway Operating Materials Costs (Richey)
4. Motormen and Conductors' Wages for State of Tennessee
5. Street Railway Fares for Country (Richey)
6. Street Railway Fares for the State of Tennessee



1. Construction Costs (Engineering News Record)
2. Street Railway Operating Materials Costs (Richey)
3. Maintenance Per Mile of Track--Knoxville
4. " " " " Memphis
5. " " " " Nashville

(Note--Curves 1 and 2 Plotted from Points of June 30th)

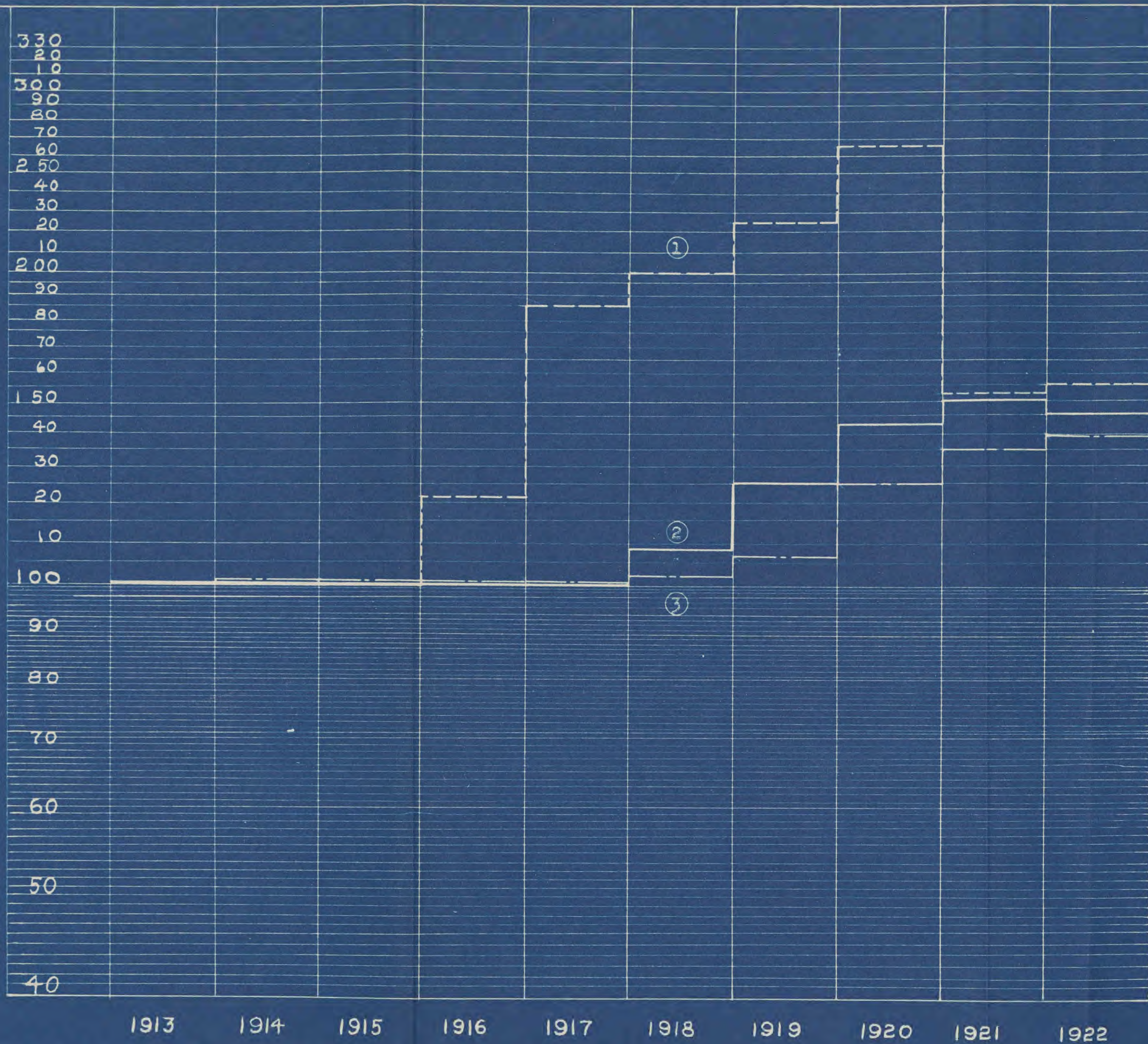


1. Wholesale Prices all Commodities (U.S. Bureau of Labor Statistics.)

2. Street Railway Fares (Richey)

3. Street Railway Fares for State.

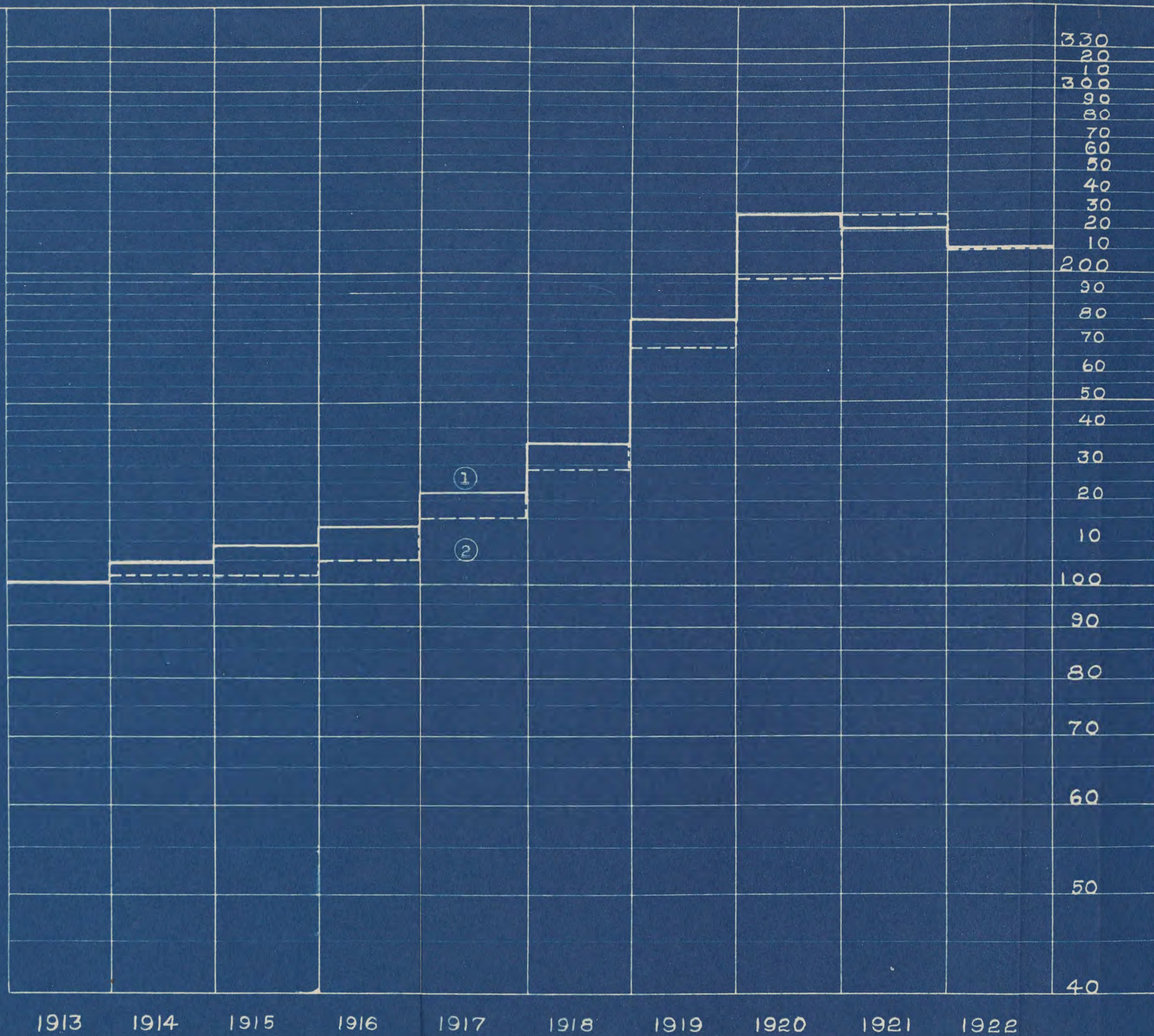
(Note-Points on Curves 1 and 2 taken off of June 30th)



STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE.

1. Street Railway Wages, Country as a Whole
2. Motormen and Conductors' Wages for State,
Weighted according to number of men employed on June 30th.

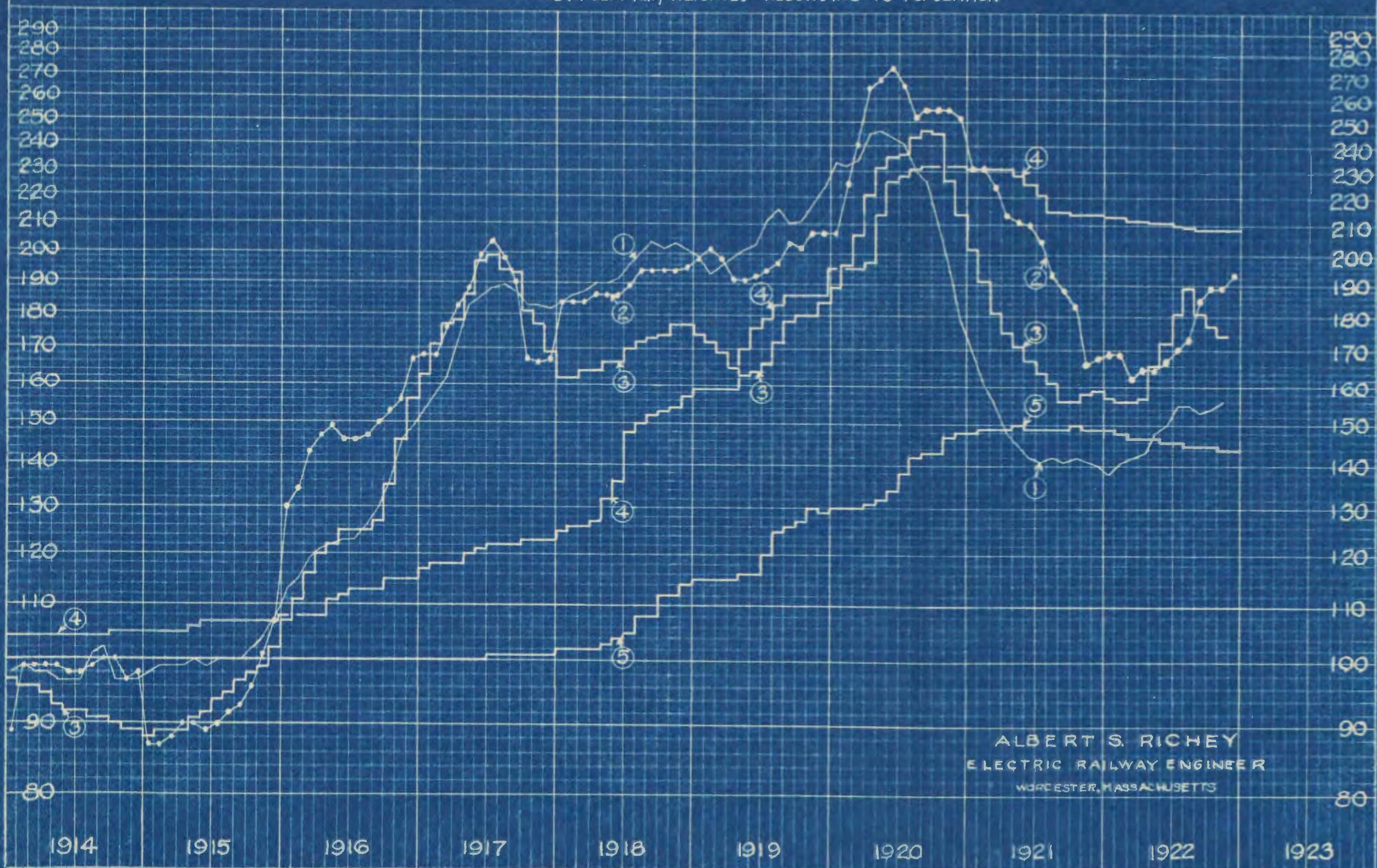
Index Basis: 1913--100%



CONSPECTUS OF INDEXES

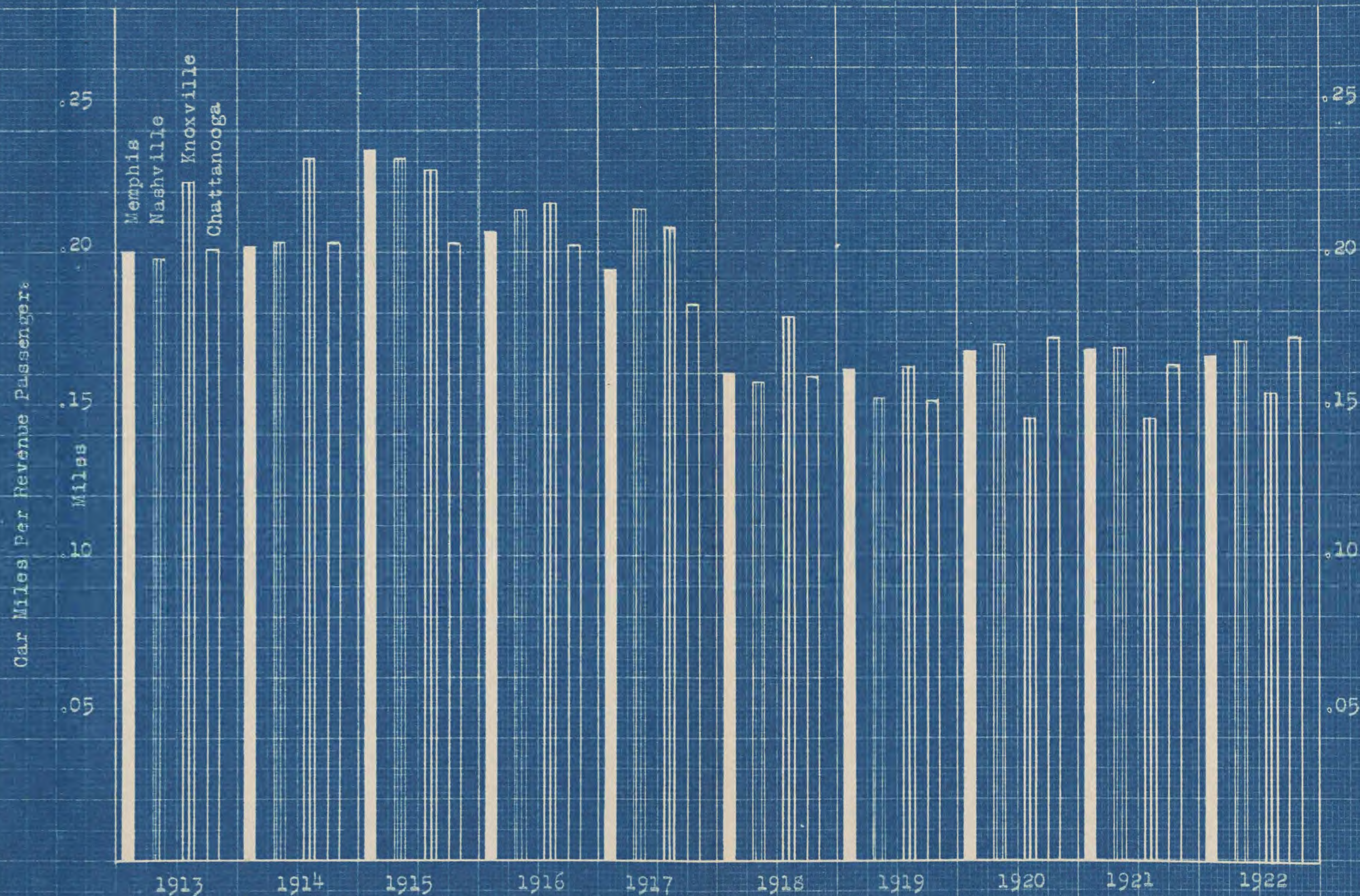
BASE: 1913=100

1. WHOLESALE PRICES ALL COMMODITIES (U.S. BUREAU OF LABOR STATISTICS - REVISED, 1922)
2. CONSTRUCTION COSTS (ENGINEERING NEWS RECORD)
3. STREET RAILWAY OPERATING MATERIALS COSTS (RICHEY)
INCLUDES FUEL FOR POWER AND WEIGHTED ACCORDING TO AVERAGE USE IN MAINTENANCE AND OPERATION.
4. STREET RAILWAY WAGES (RICHEY)
MAXIMUM HOURLY WAGES OF PLATFORM MEN, WEIGHTED ACCORDING TO NUMBER OF MEN.
5. STREET RAILWAY FARES (RICHEY)
U.S. CITIES (EXCEPT N.Y.) WEIGHTED ACCORDING TO POPULATION



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Memphis
Nashville
Knoxville
Chattanooga



STUDY OF OPERATING EFFICIENCY OF TENNESSEE STREET RAILWAYS

REVENUE FARE AS DISTRIBUTED BY EACH OF
THREE PRINCIPAL STREET RAILWAY SYSTEMS
YEARS 1913 & 1922

1922

7¢

7¢

6¢

MEMPHIS

NASHVILLE

KNOXVILLE

1913

5¢

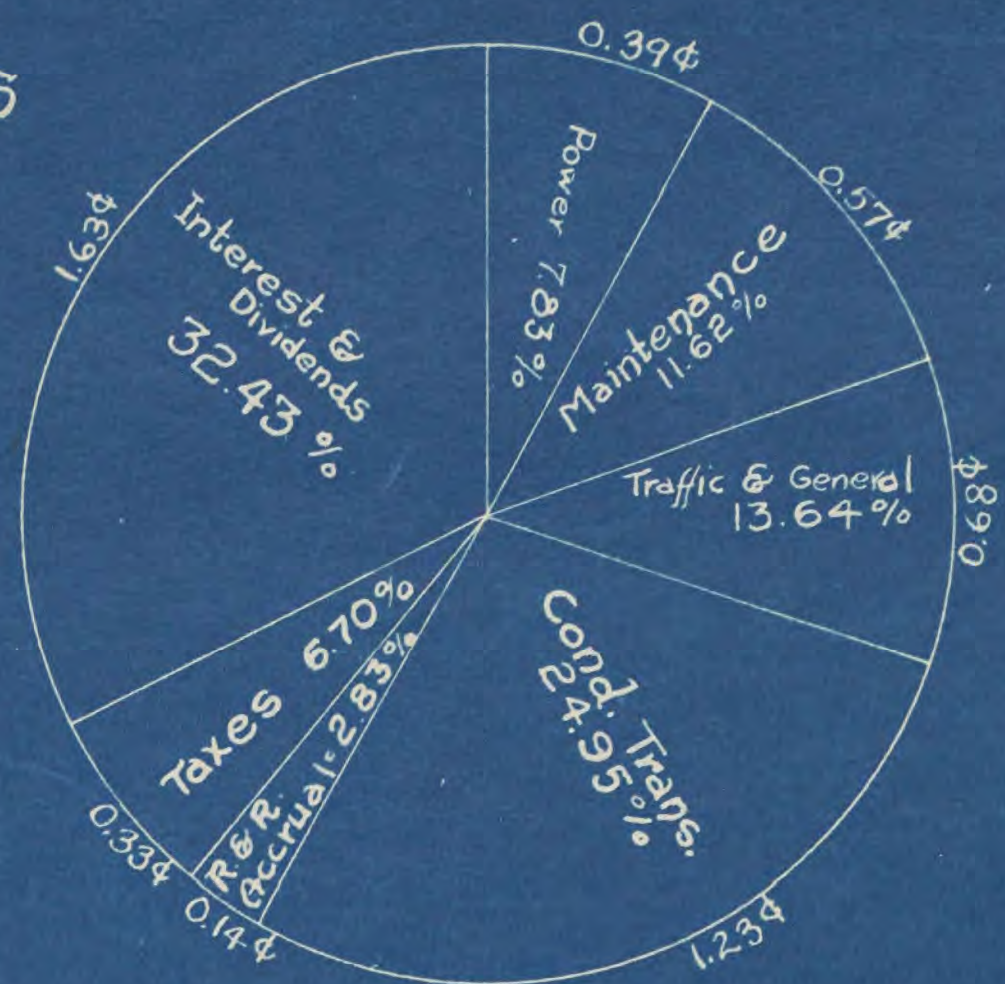
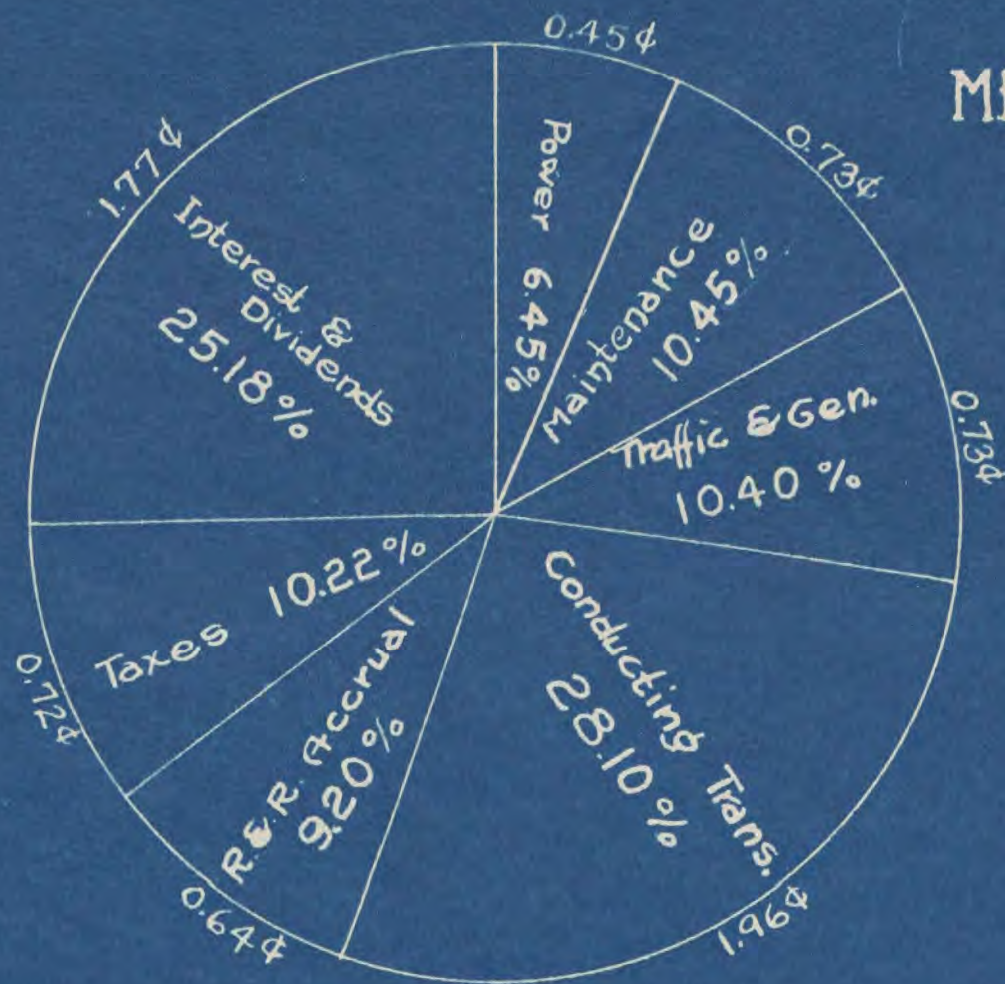
5¢

5¢

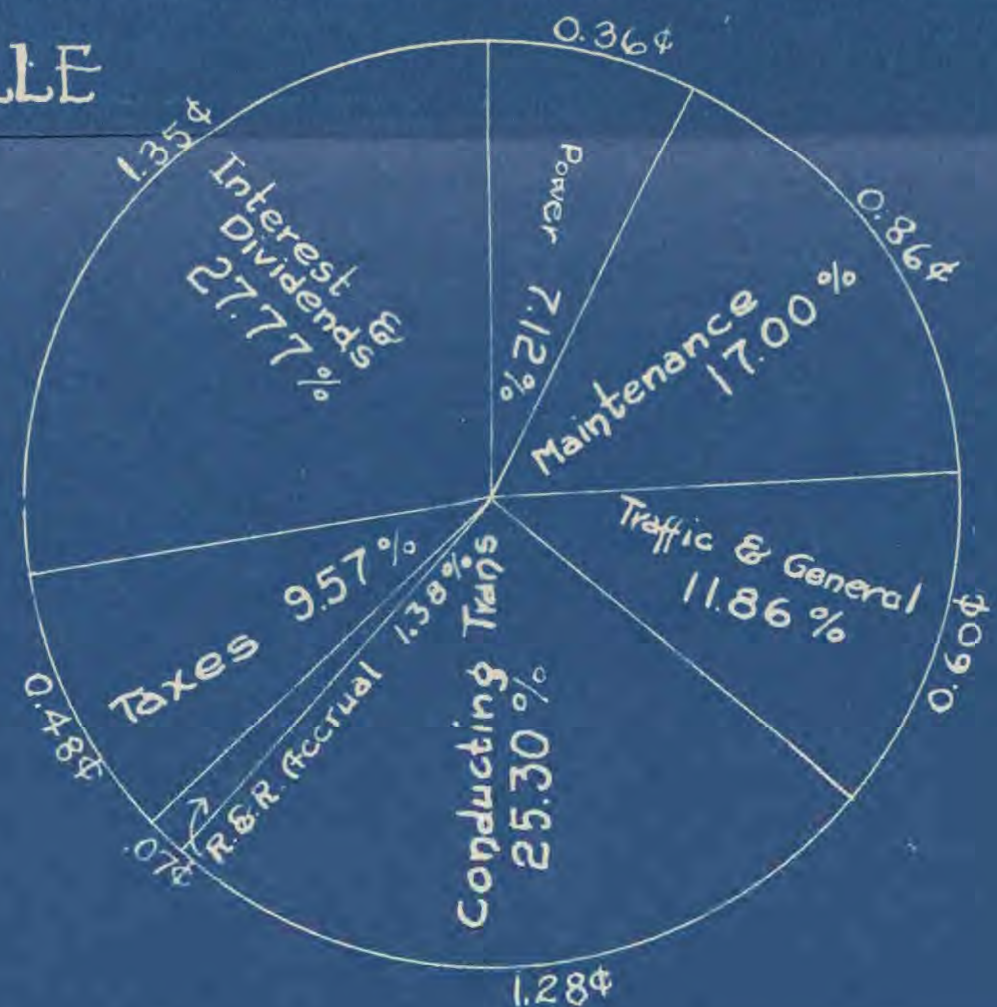
1922

1913

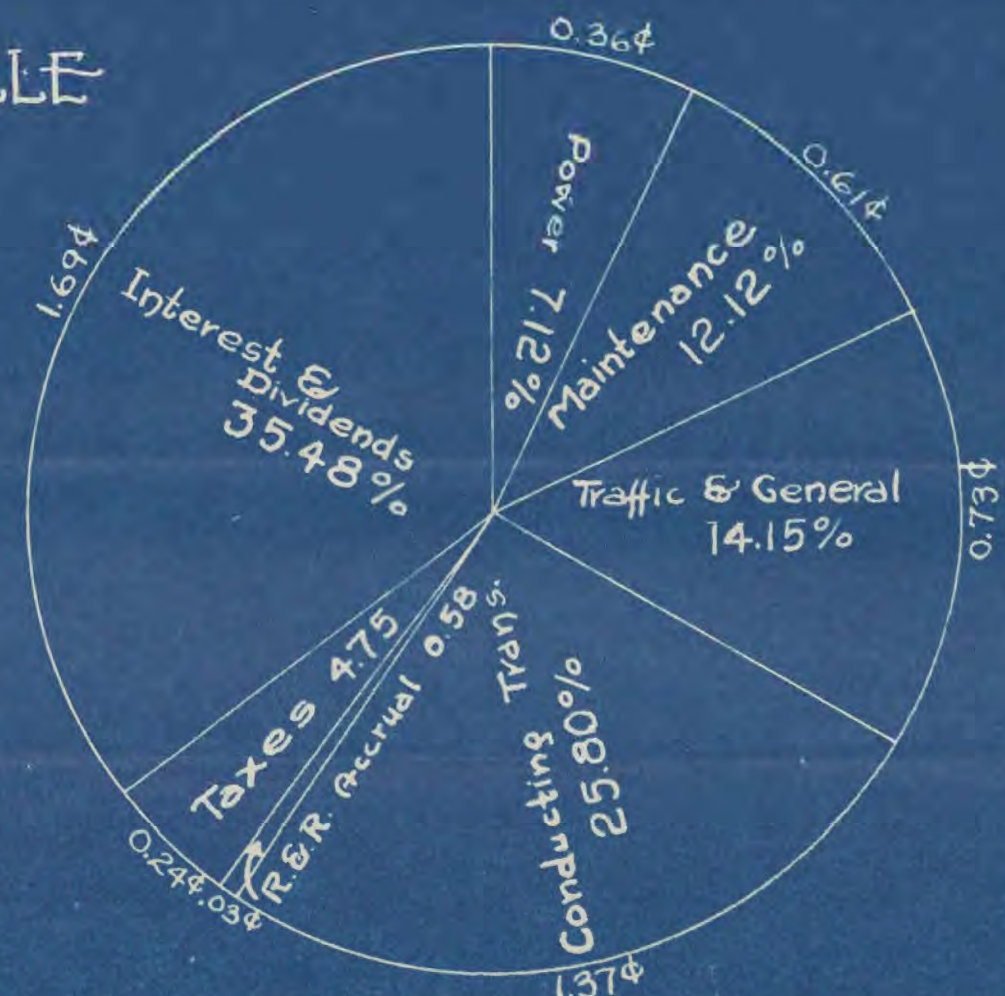
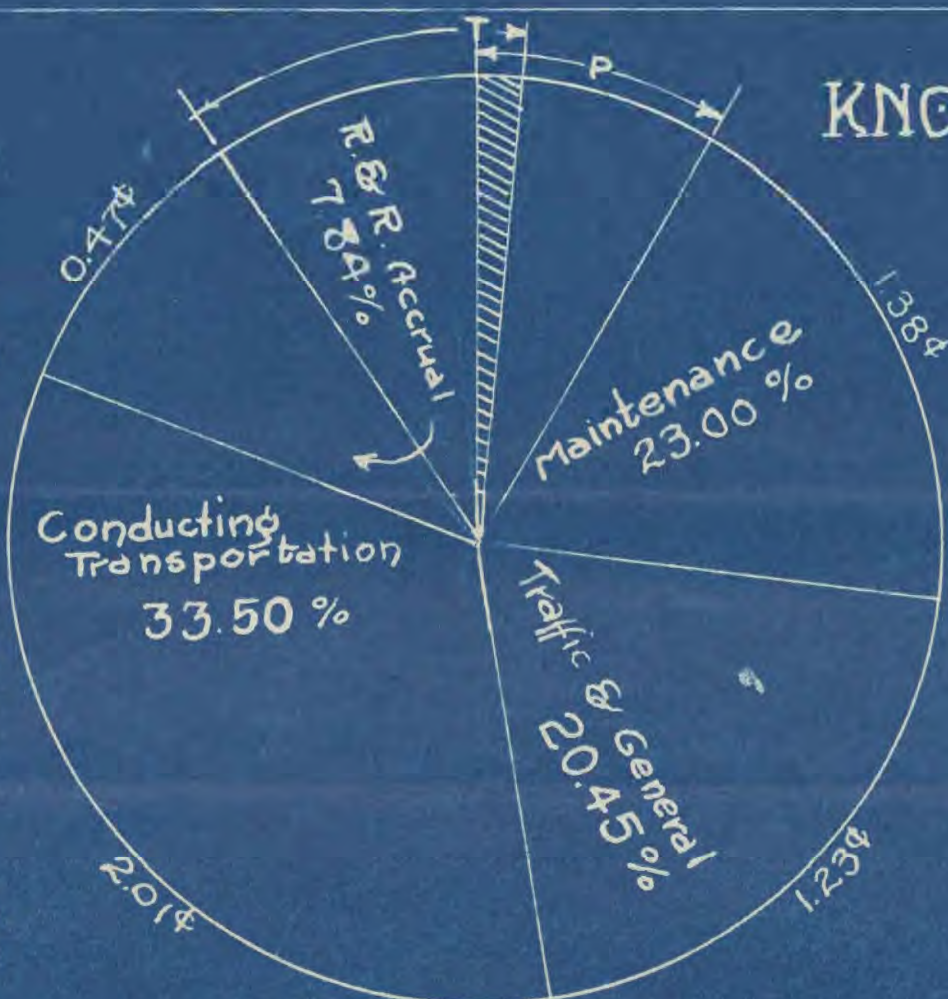
MEMPHIS



NASHVILLE



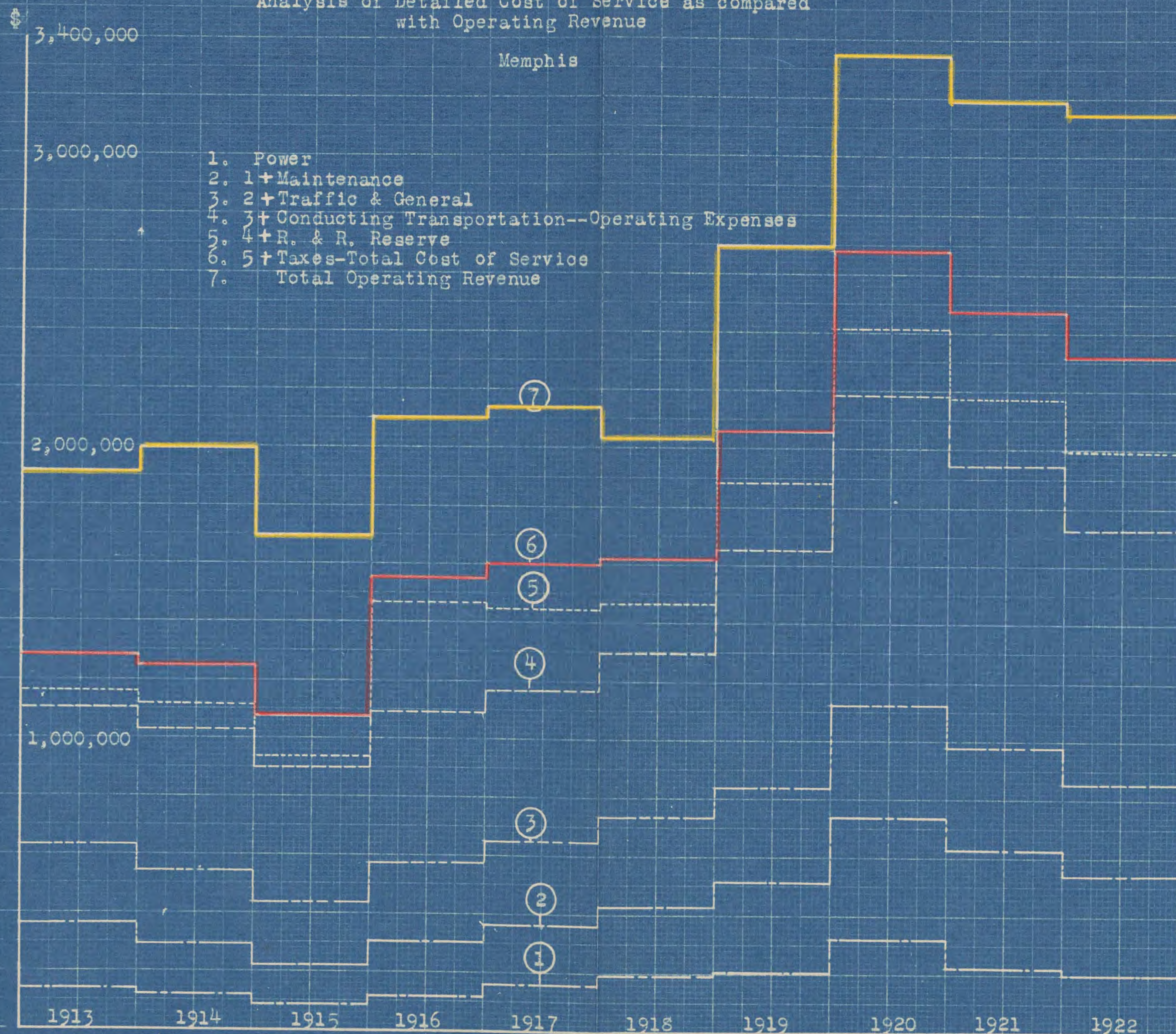
KNOXVILLE



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Detailed Cost of Service as compared
with Operating Revenue

Memphis



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Details of Cost of Service as Compared with
Operating Revenue.

Nashville

1. Power
2. 1 + Maintenance
3. 2 + Traffic and General
4. 3 + Conducting Transportation-
Operating ~~Expense~~
5. 4 + R & R Accrual ~~Expense~~
6. 5 + Taxes-Total Cost of Service
7. Total Operating Revenue

\$ 2,500,000

2,000,000

1,000,000

1913

14

15

16

17

18

19

20

21

1922

\$1,000,000

STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE

Analysis of Detailed Cost of Service as compared with
Operating Revenue

Knoxville

700,000

600,000

500,000

400,000

300,000

200,000

100,000

1. Power
2. 1+Maintenance
3. 2+Traffic & General
4. 3+Conducting Transportation-
Operating Expenses
5. 4+R. & R. Reserve
6. 5+Taxes- Total Cost of
Service)
7. Total Operating Revenue.

1913

1914

1915

1916

1917

1918

1919

1920

1921

1922

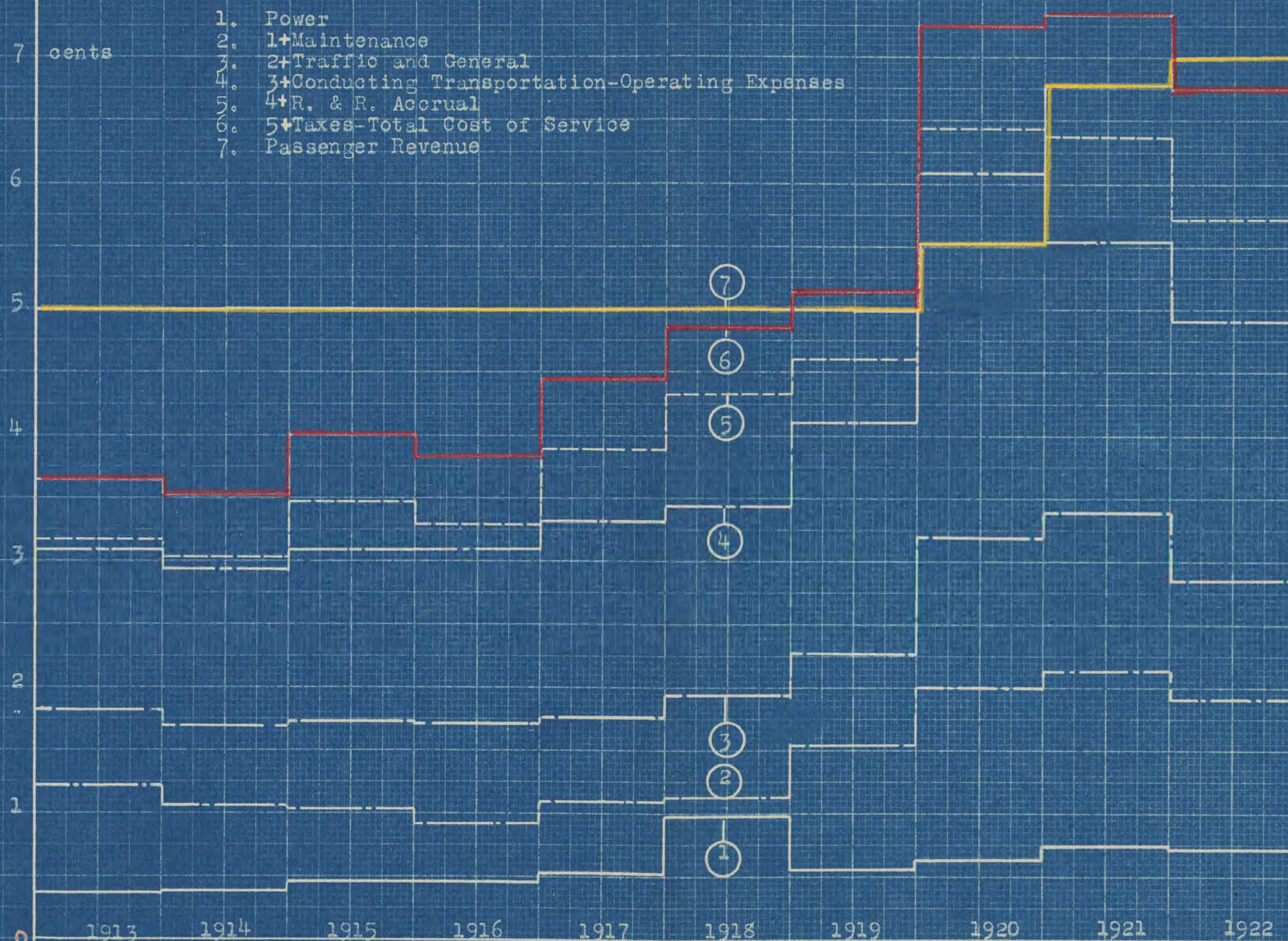
STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Distribution of Passenger Revenue Per Revenue Passenger Memphis



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

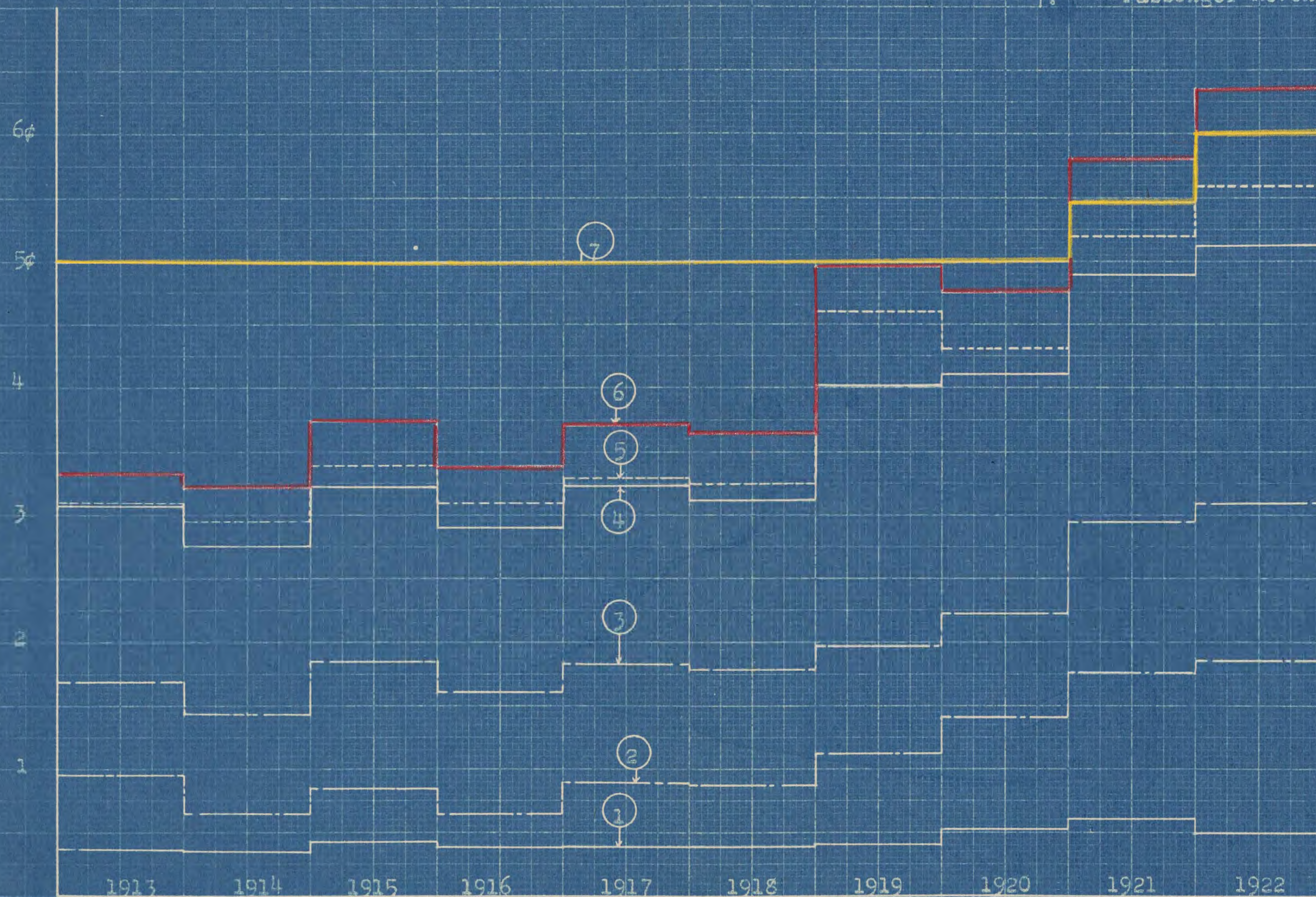
Distribution of Passenger Revenue Per Revenue Passenger
Nashville



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

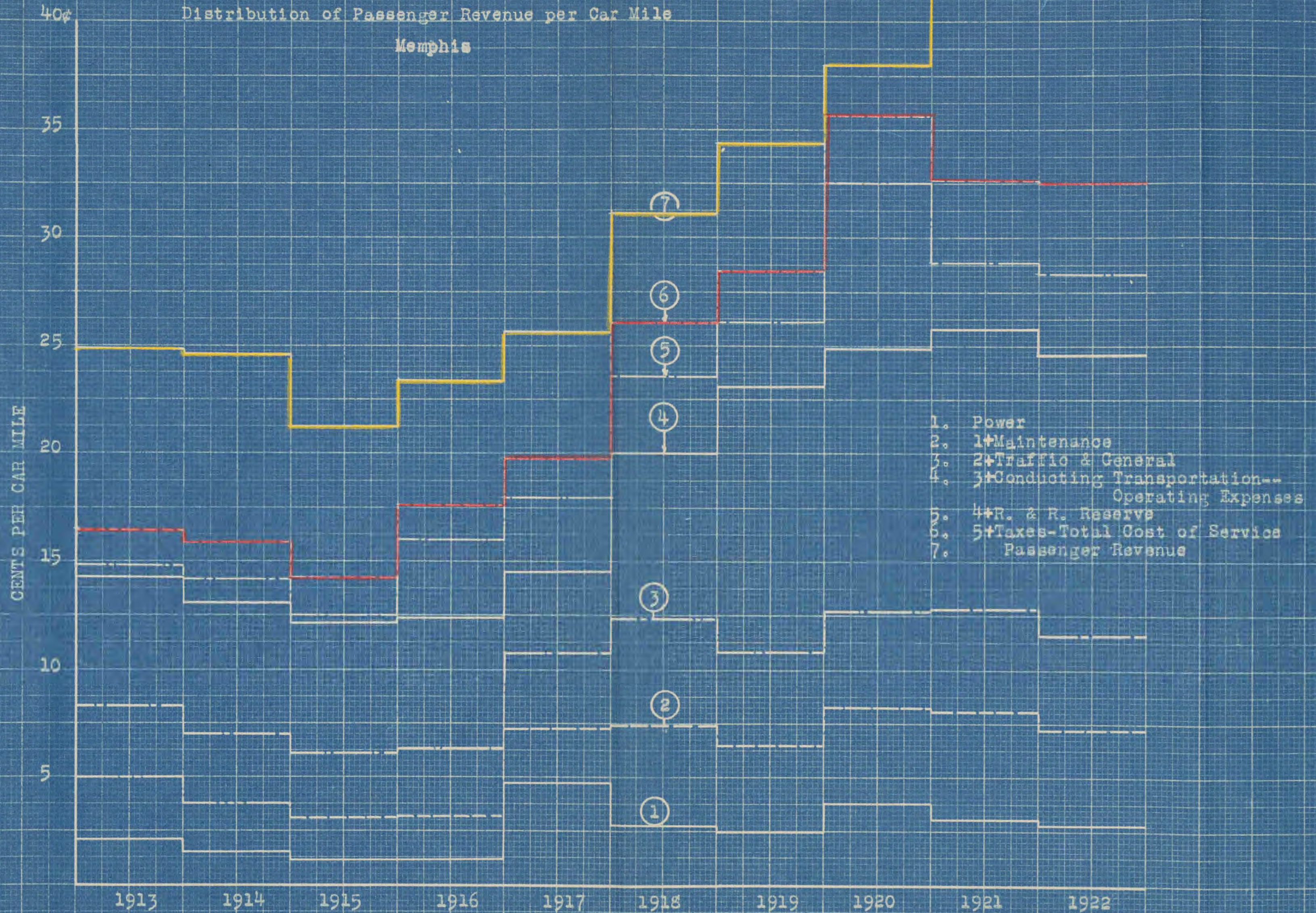
Distribution of Passenger Revenue per Revenue Passenger Knoxville

1. Power
2. 1+Maintenance
3. 2+Traffic & General
4. 3+Conducting Transportation—
Operating Expenses
5. 4+R. & R. Reserve
6. 5+Taxes—Total Cost of Service
7. Passenger Revenue



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Distribution of Passenger Revenue per Car Mile
Memphis



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Distribution of Passenger Revenue per Car Mile Nashville

40¢

35

30

25

20

15

10

5

1. Power
2. 1+ Maintenance
3. 2+ Traffic & General
4. 3+ Conducting Transportation-
Operating Expenses.
5. 4+ R. & R. Reserve
6. 5+ Taxes-Total Cost of Service
7. Passenger Revenue

1913

1914

1915

1916

1917

1918

1919

1920

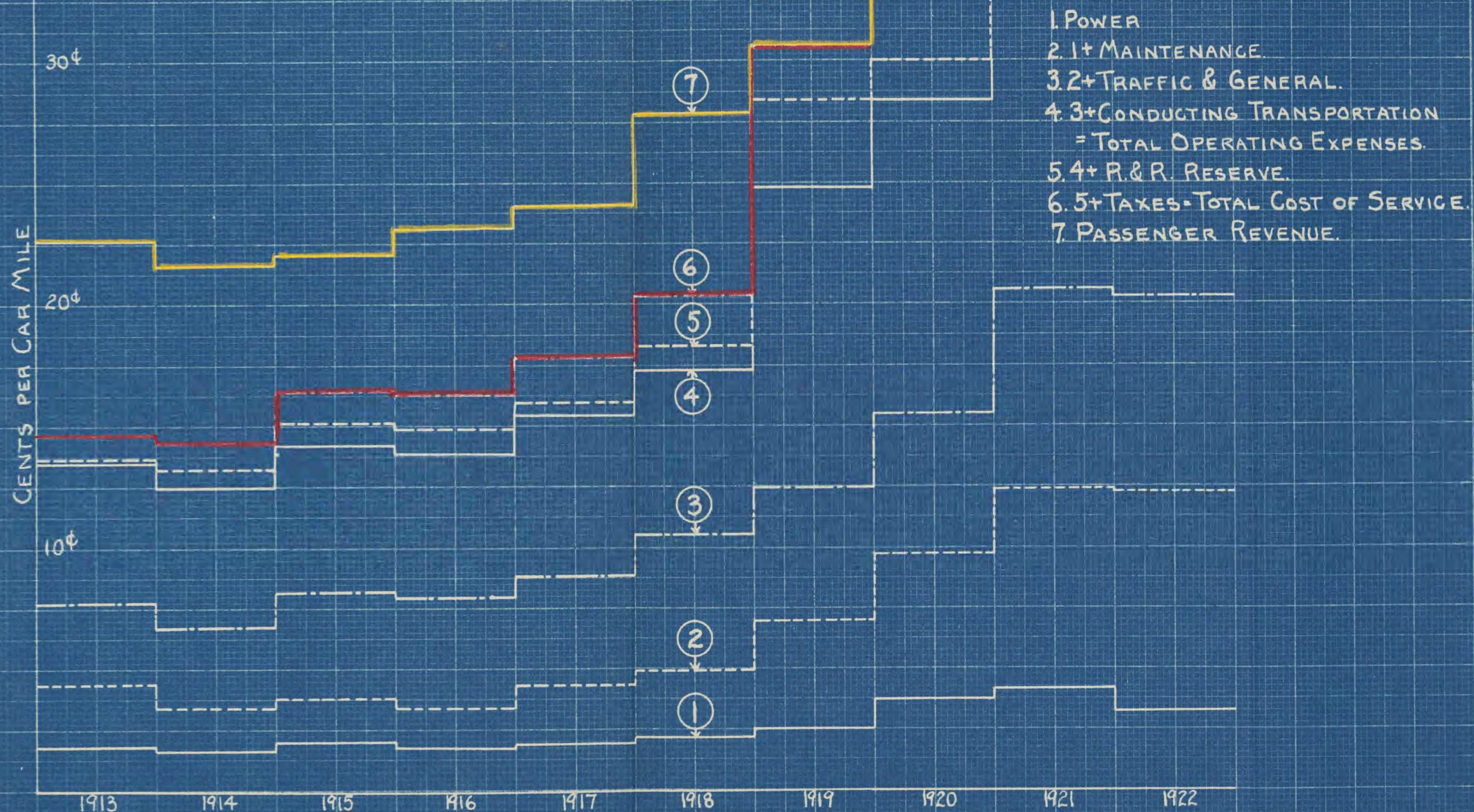
1921

1922

STUDY OF OPERATING EFFICIENCY OF

STREET RAILWAYS OF TENNESSEE.

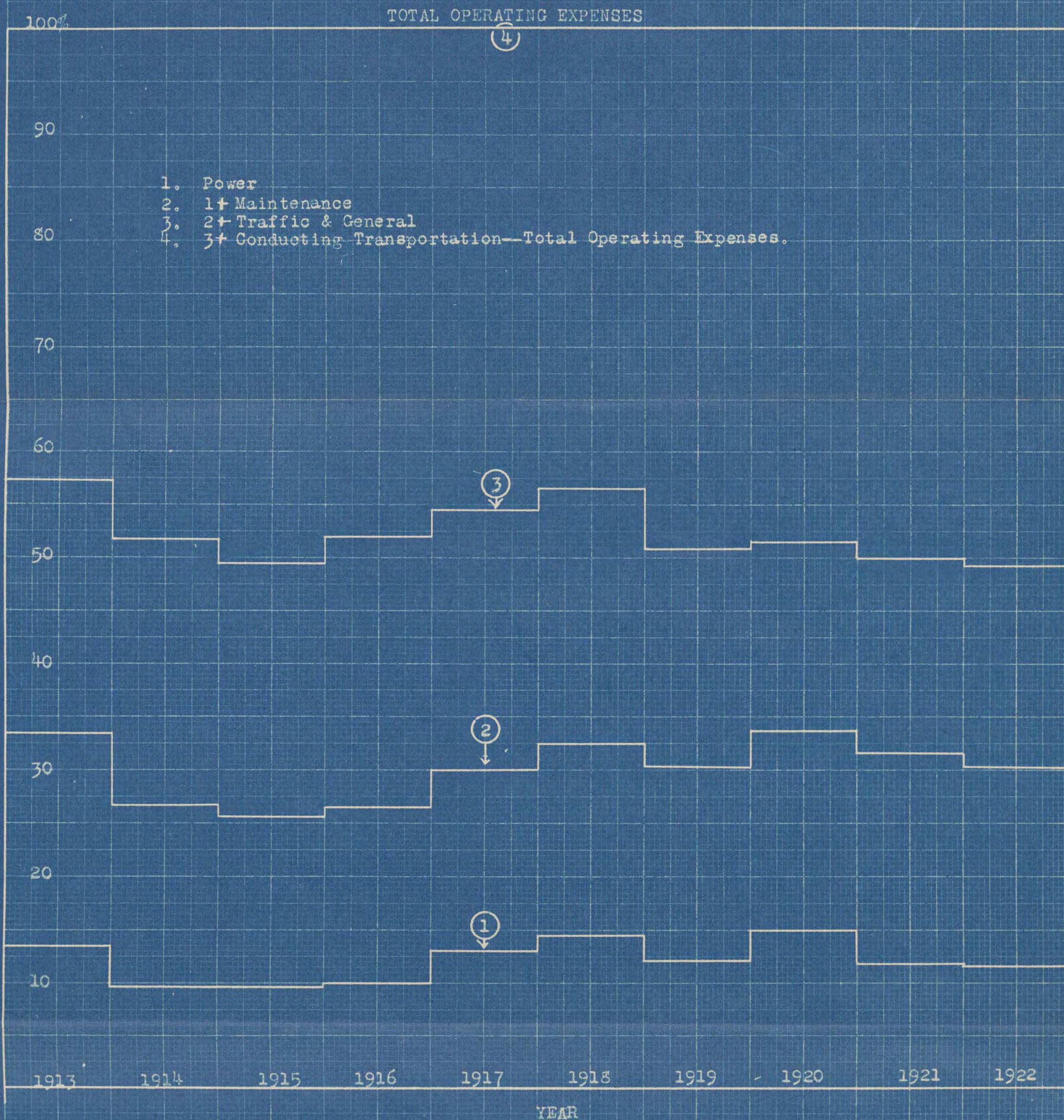
DISTRIBUTION OF PASSENGER REVENUE PER CAR MILE. KNOXVILLE.



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Ratio of Detailed Operating Expenses to Total
Operating Expenses

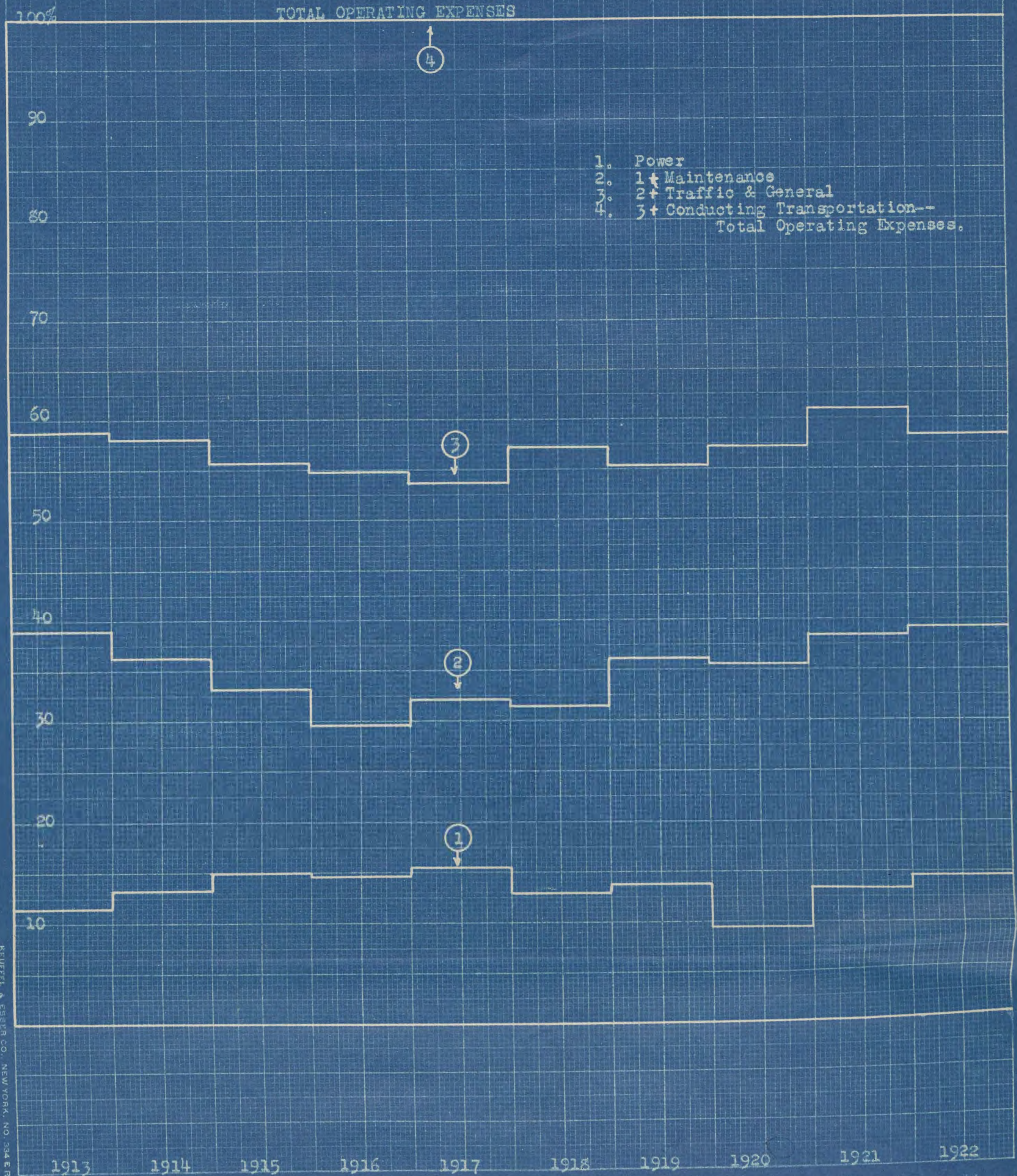
Memphis



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Ratio of Detailed Operating Expenses to Total
Operating Expenses

Nashville



STUDY OF OPERATING EFFICIENCY
Of
STREET RAILWAYS OF TENNESSEE

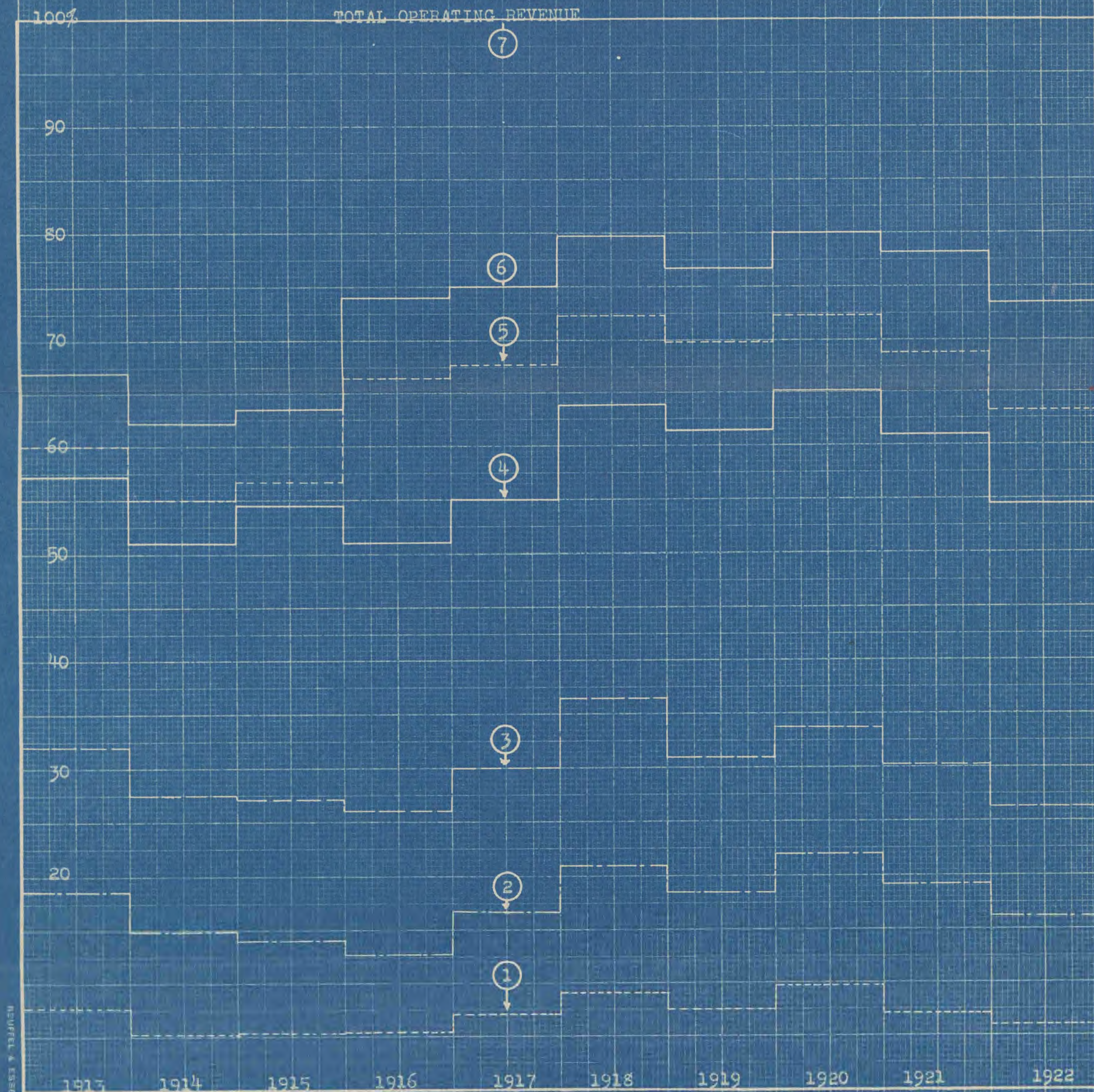
Ratio of Detailed Operating Expenses
Knoxville



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Relation of Cost of Service to Revenue Memphis

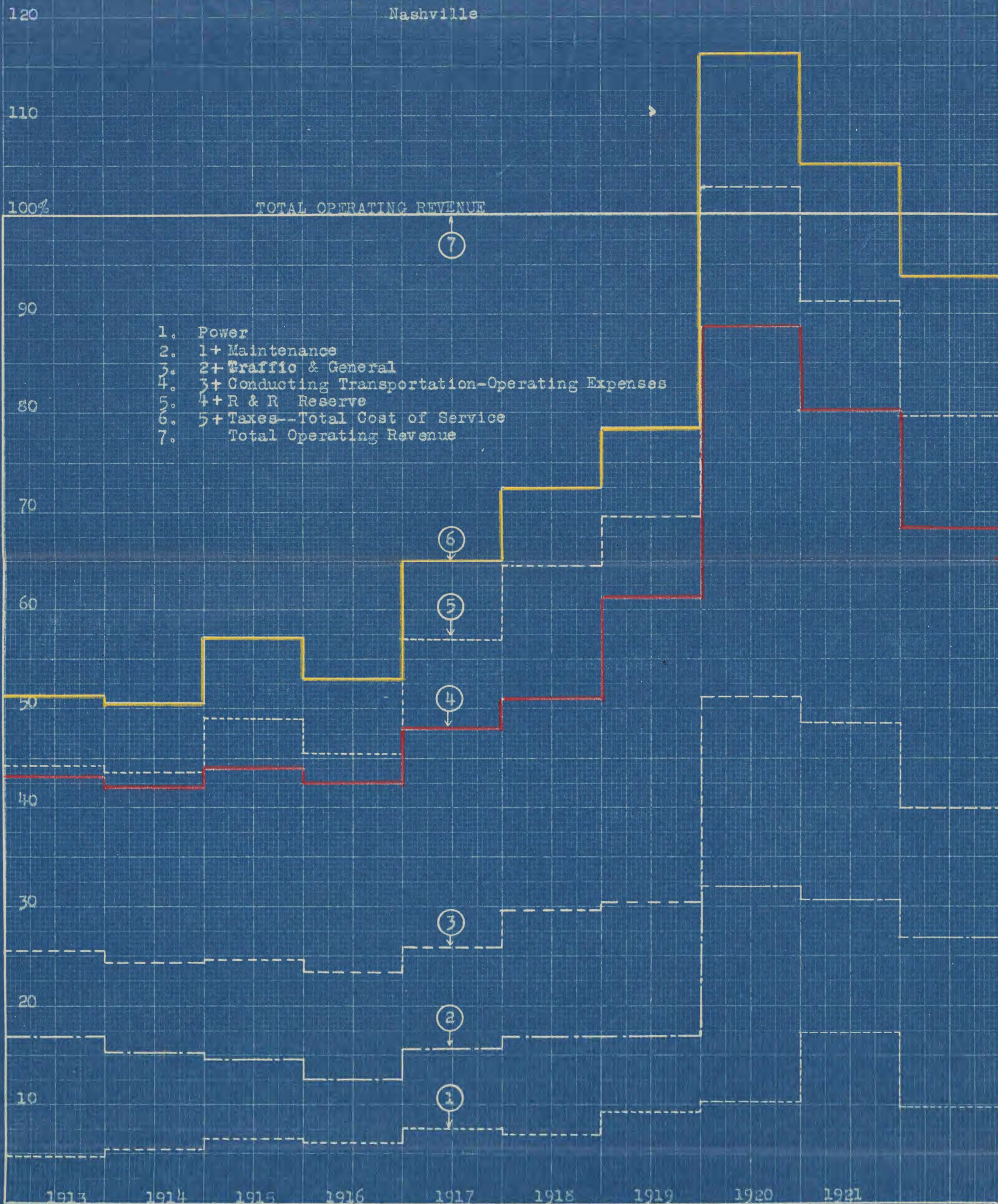
1. Power
2. 1+Maintenance
3. 2+Traffic & General
4. 3+Conducting Transportation
Operating Expenses
5. 4+R. & R. Reserve
6. 5+Taxes-Total Cost of
Service)
7. Total Operating Revenue.



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

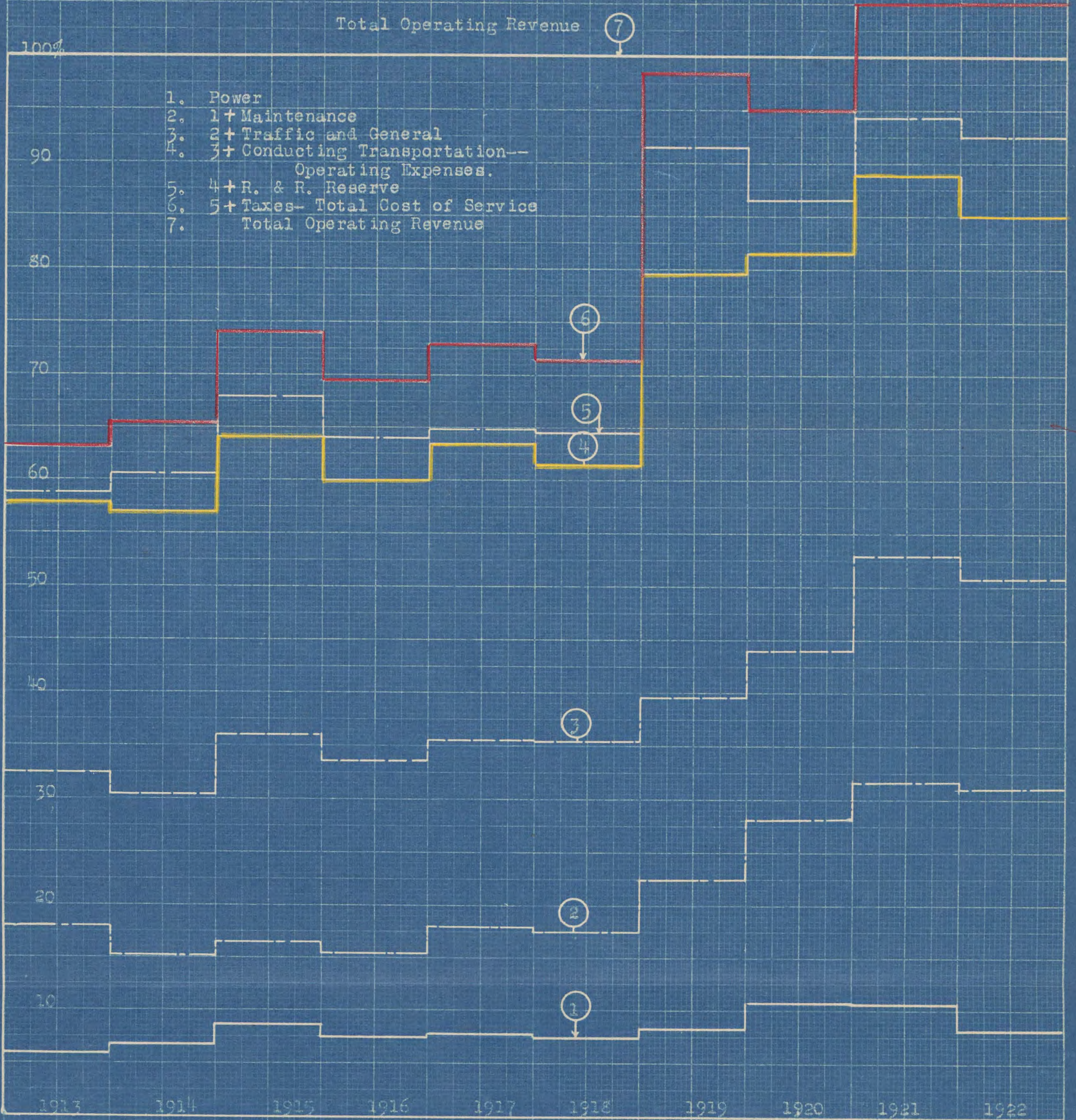
Relation of Cost of Service to Revenue

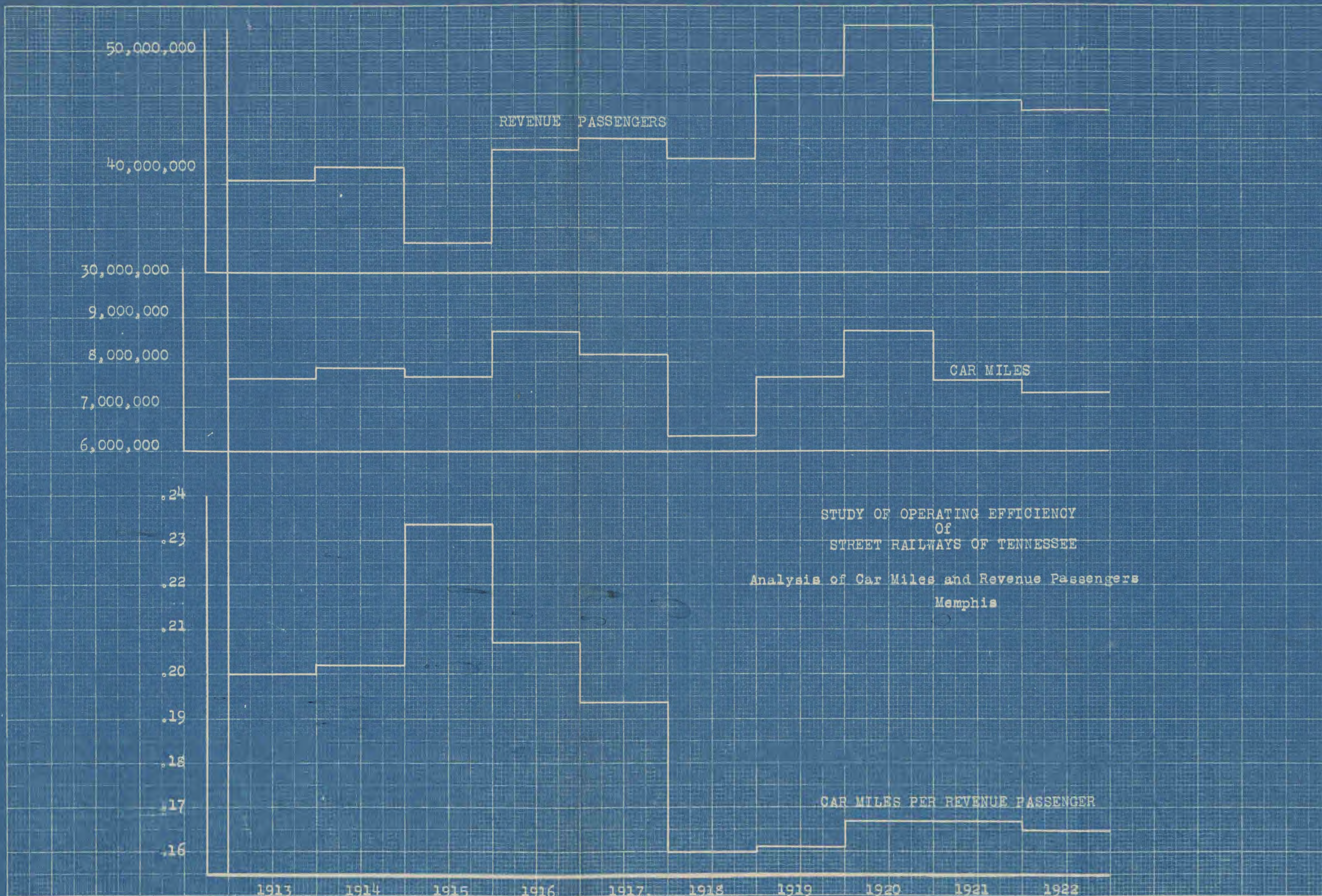
Nashville



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

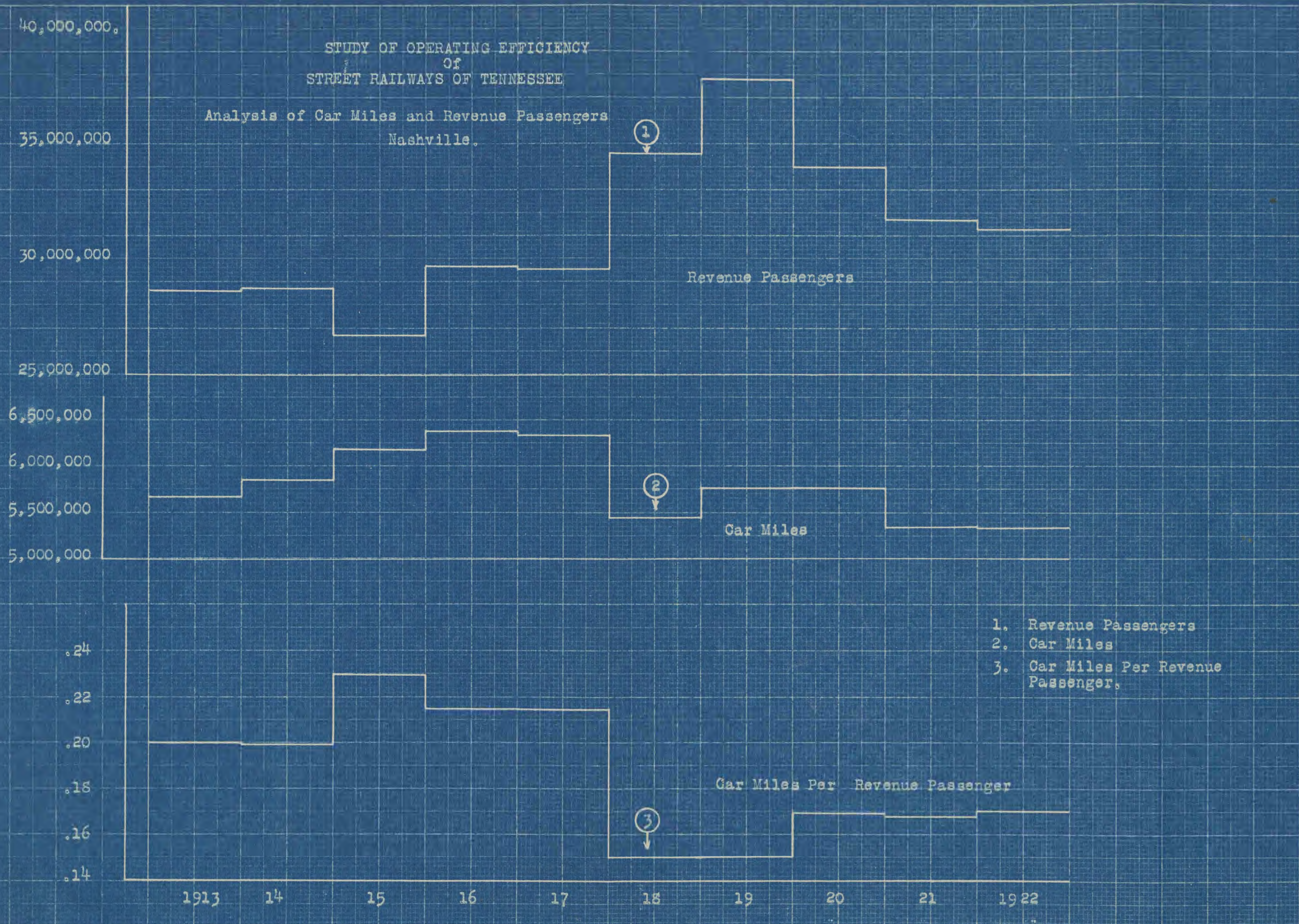
Relation of Cost of Service to Revenue Knoxville





STUDY OF OPERATING EFFICIENCY of STREET RAILWAYS OF TENNESSEE

Analysis of Car Miles and Revenue Passengers
Nashville.



- 1. Revenue Passengers
- 2. Car Miles
- 3. Car Miles Per Revenue Passenger.

STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Car Miles and Revenue Passengers
Knoxville

REVENUE PASSENGERS

1. Revenue Passengers
2. Car Miles
3. Car Miles Per Revenue Passenger)

15,000,000
14,000,000
13,000,000
12,000,000
11,000,000
10,000,000
9,000,000

2,500,000
2,000,000

.23
.22
.21
.20
.19
.18
.17
.16
.15
.14

CAR MILES

CAR MILES PER REVENUE PASSENGER

1913 1914 1915 1916 1917 1918 1919 1920 1921 1922

STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Volume of Business (Revenue Passengers)

Memphis
Nashville
Knoxville
Chattanooga

Revenue Passengers
60,000,000

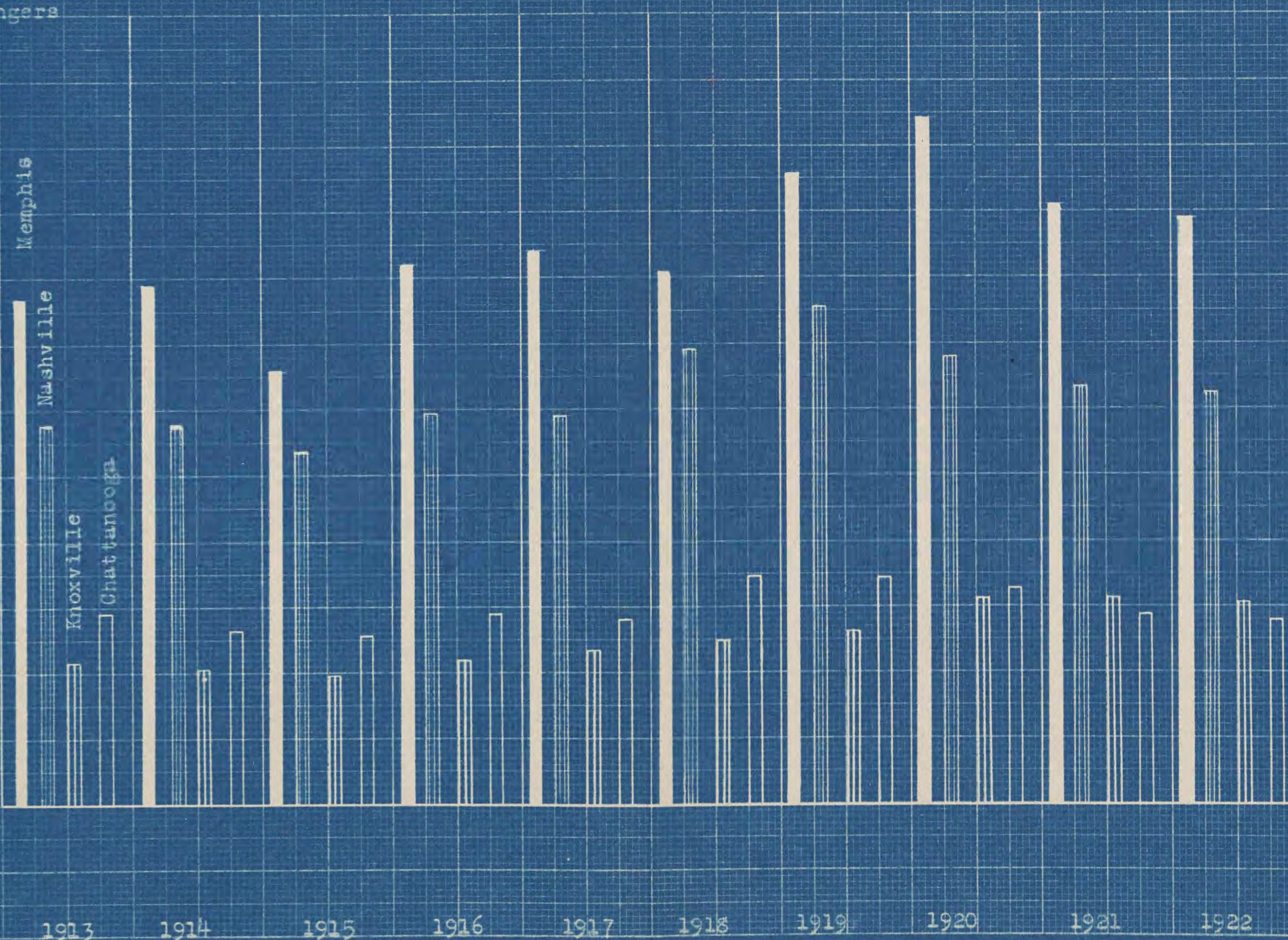
50,000,000

40,000,000

30,000,000

20,000,000

10,000,000



LEGEND

ACCRUAL

PAYMENT

\$400,000

300,000

200,000

100,000

0

MEMPHIS

NASHVILLE

KNOXVILLE

1913

1914

1915

1916

1917

1918

1919

1920

1921

1922

RENEWALS & REPLACEMENTS.

\$400,000

300,000

200,000

100,000

0

MEMPHIS

NASHVILLE

KNOXVILLE

1913

1914

1915

1916

1917

1918

1919

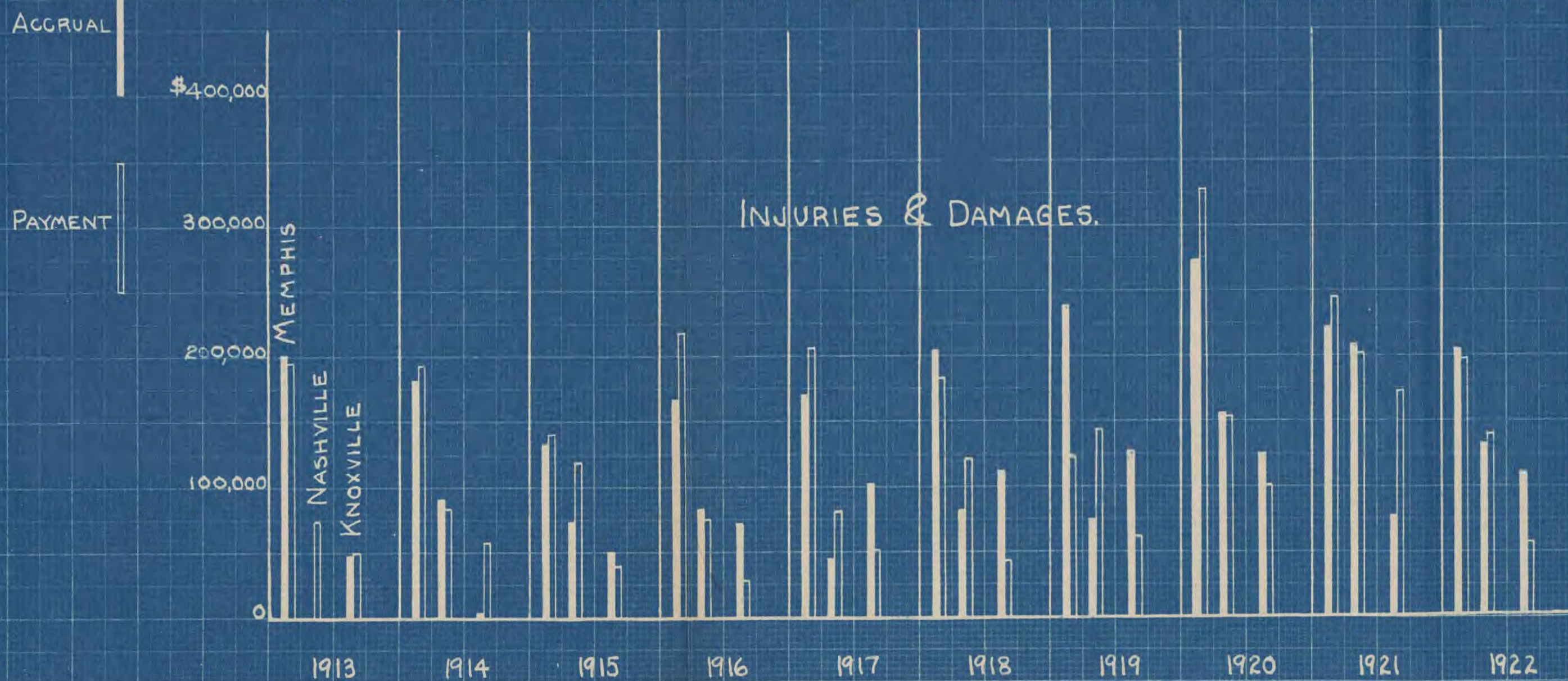
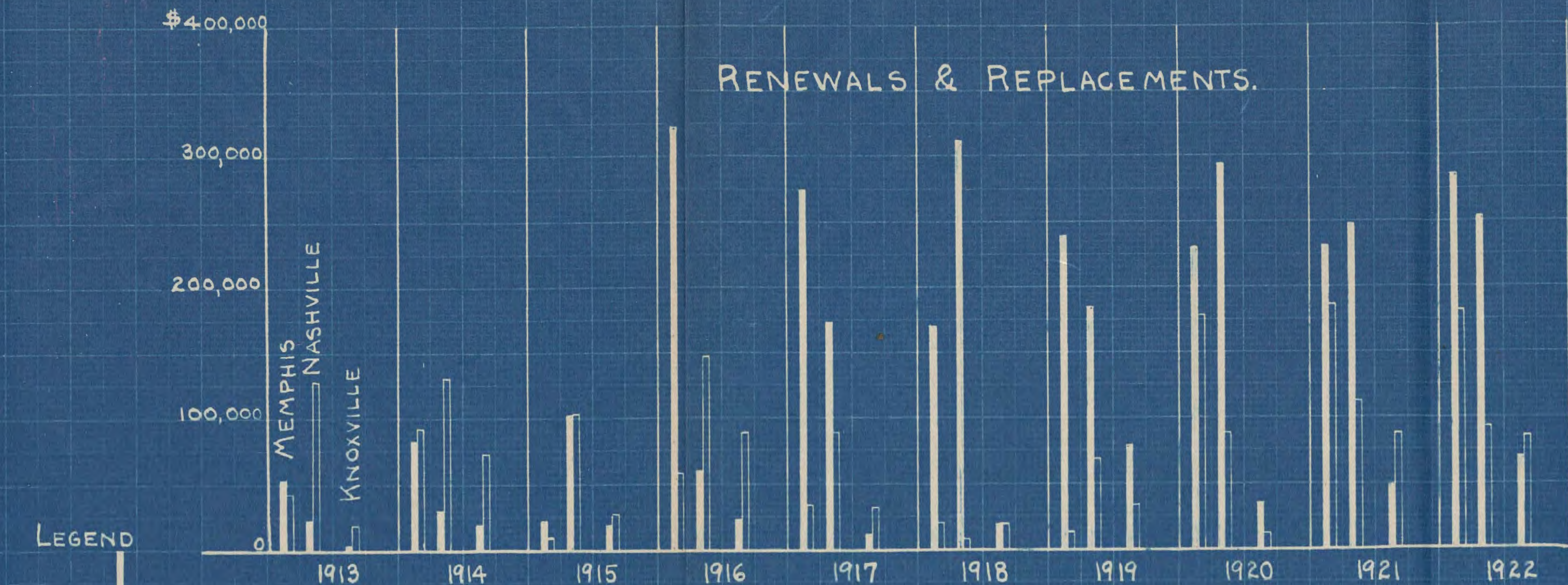
1920

1921

1922

INJURIES & DAMAGES.

STUDY OF OPERATING EFFICIENCY
OF
STREET RAILWAYS OF TENNESSEE.
MEMPHIS
NASHVILLE
KNOXVILLE.



STUDY OF OPERATING EFFICIENCY
 OF
 STREET RAILWAYS OF TENNESSEE.
 MEMPHIS
 NASHVILLE
 KNOXVILLE.

STUDY OF OPERATING EFFICIENCY
Of
STREET RAILWAYS OF TENNESSEE

Relation of Cost of Service to Revenue

Memphis

\$ 3,000,000

2,000,000

1,000,000

1913

1914

1915

1916

1917

1918

1919

1920

1921

1922

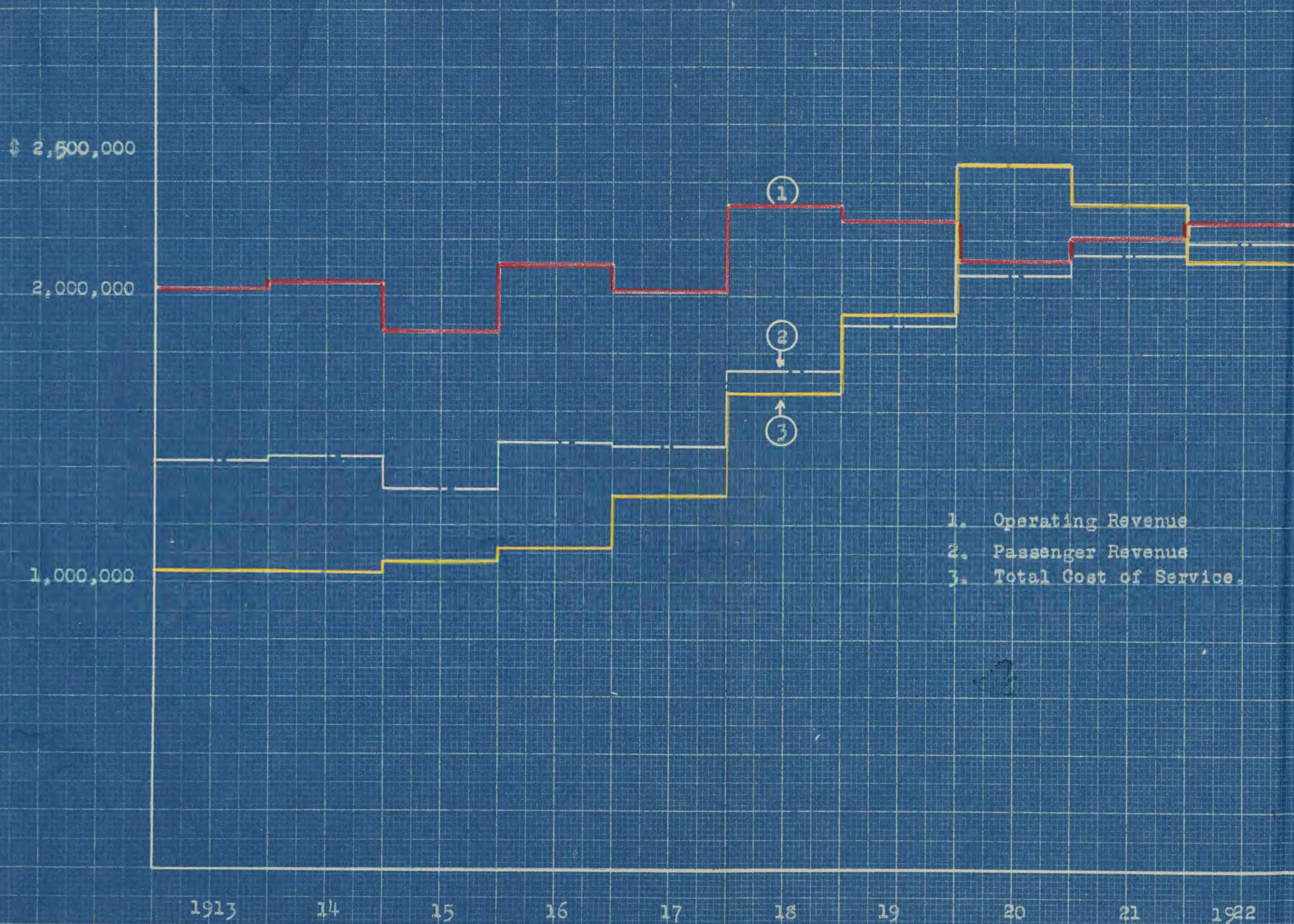
①

②

③

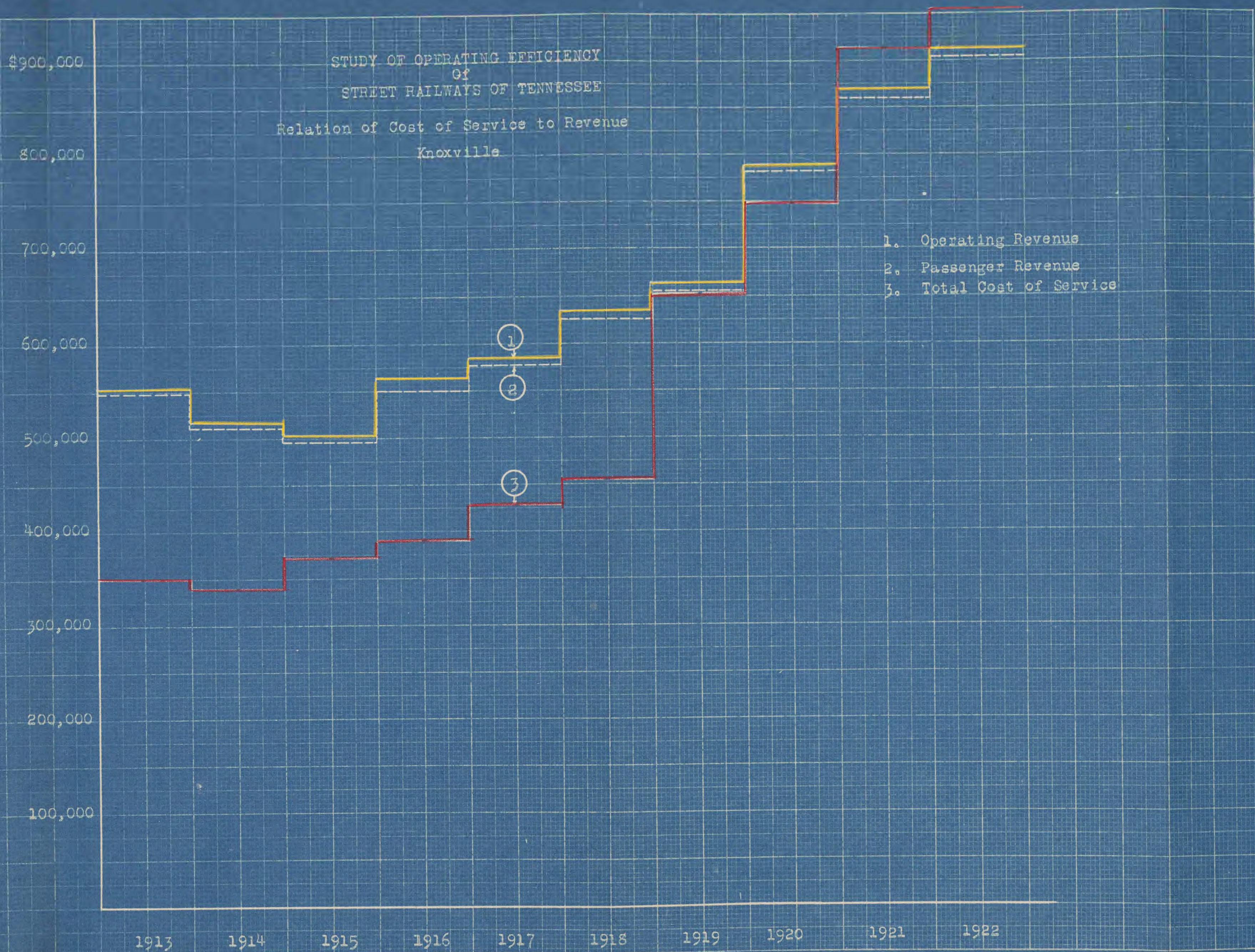
- 1. Operating Revenue
- 2. Passenger Revenue
- 3. Total Cost of Service

STUDY OF OPERATING EFFICIENCY
of
STREET RAILWAYS OF TENNESSEE
Nashville.



1. Operating Revenue
2. Passenger Revenue
3. Total Cost of Service.

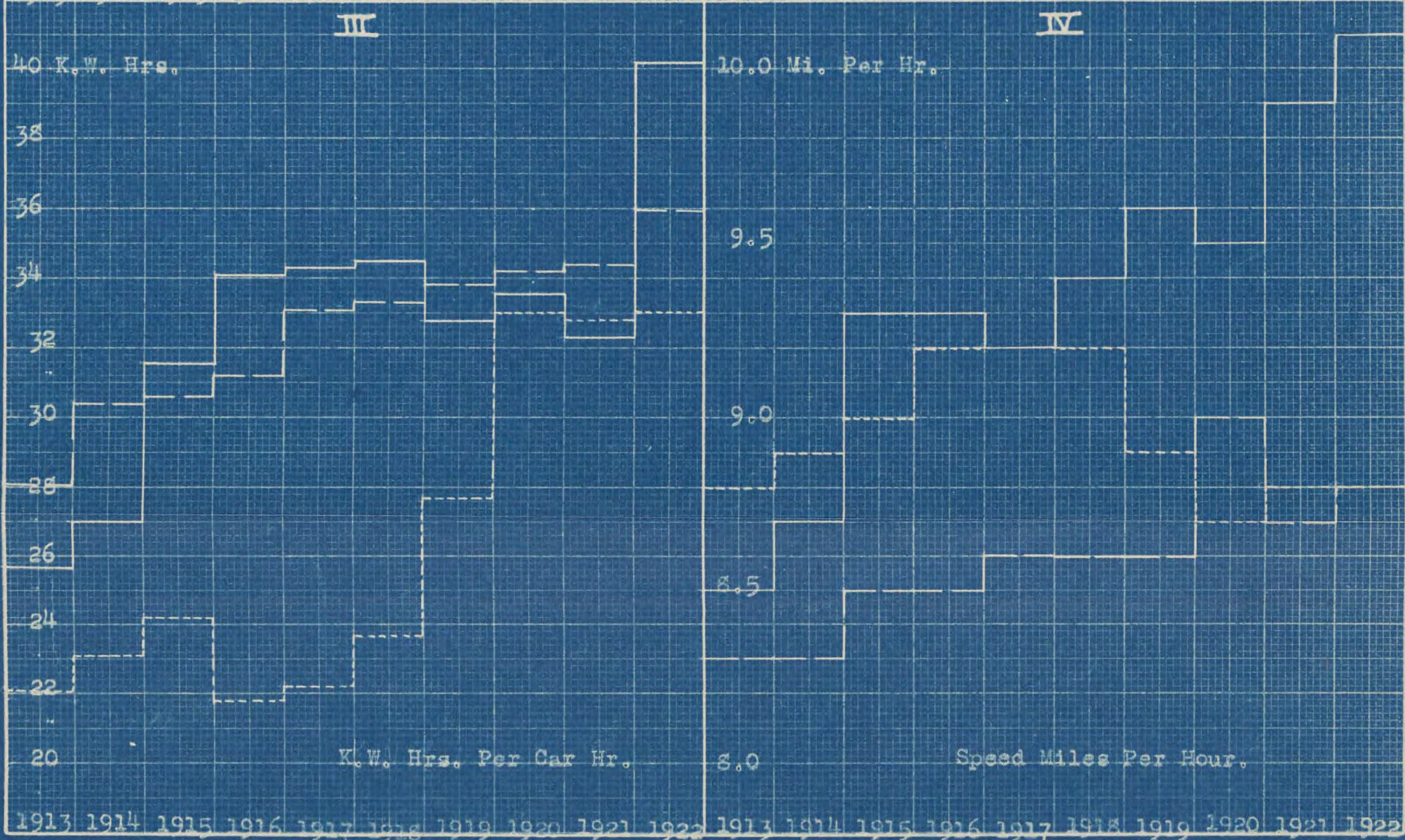
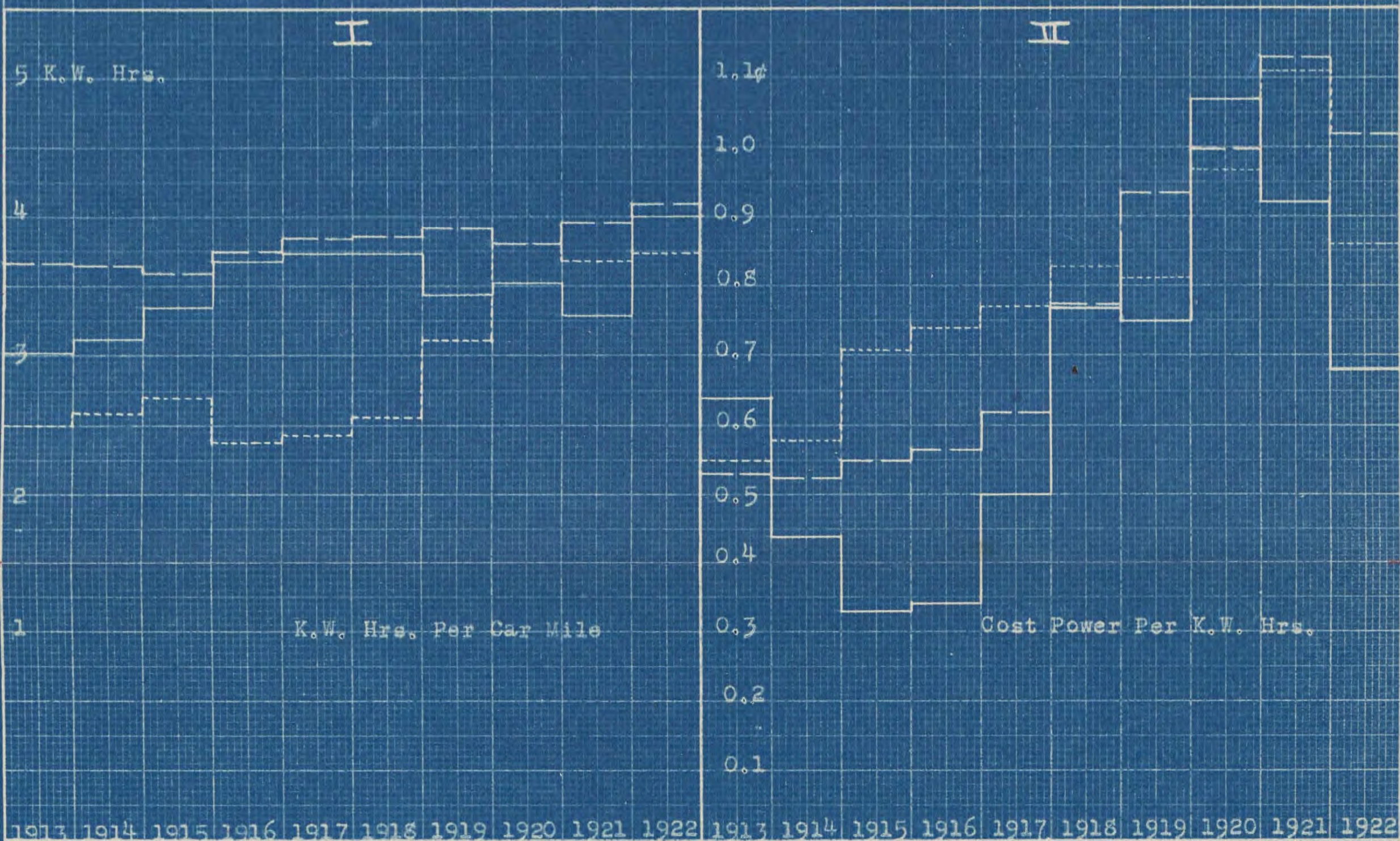
STUDY OF OPERATING EFFICIENCY
 OF
 STREET RAILWAYS OF TENNESSEE
 Relation of Cost of Service to Revenue
 Knoxville



STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE

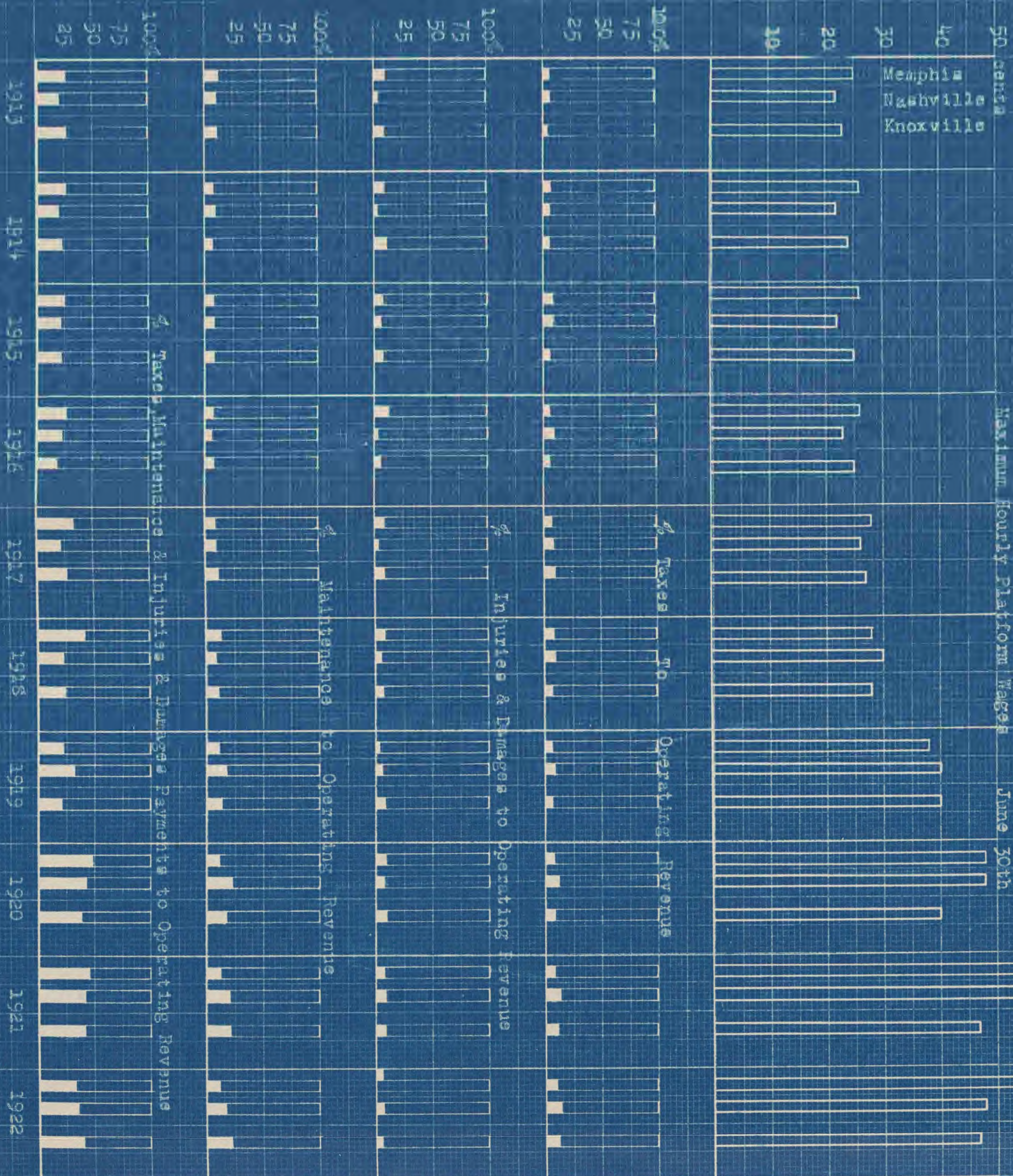
Memphis
Nashville
Knoxville

Legend
 ————— Memphis
 ————— Nashville
 - - - - - Knoxville



STUDY OF OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE

Memphis
Nashville
Knoxville

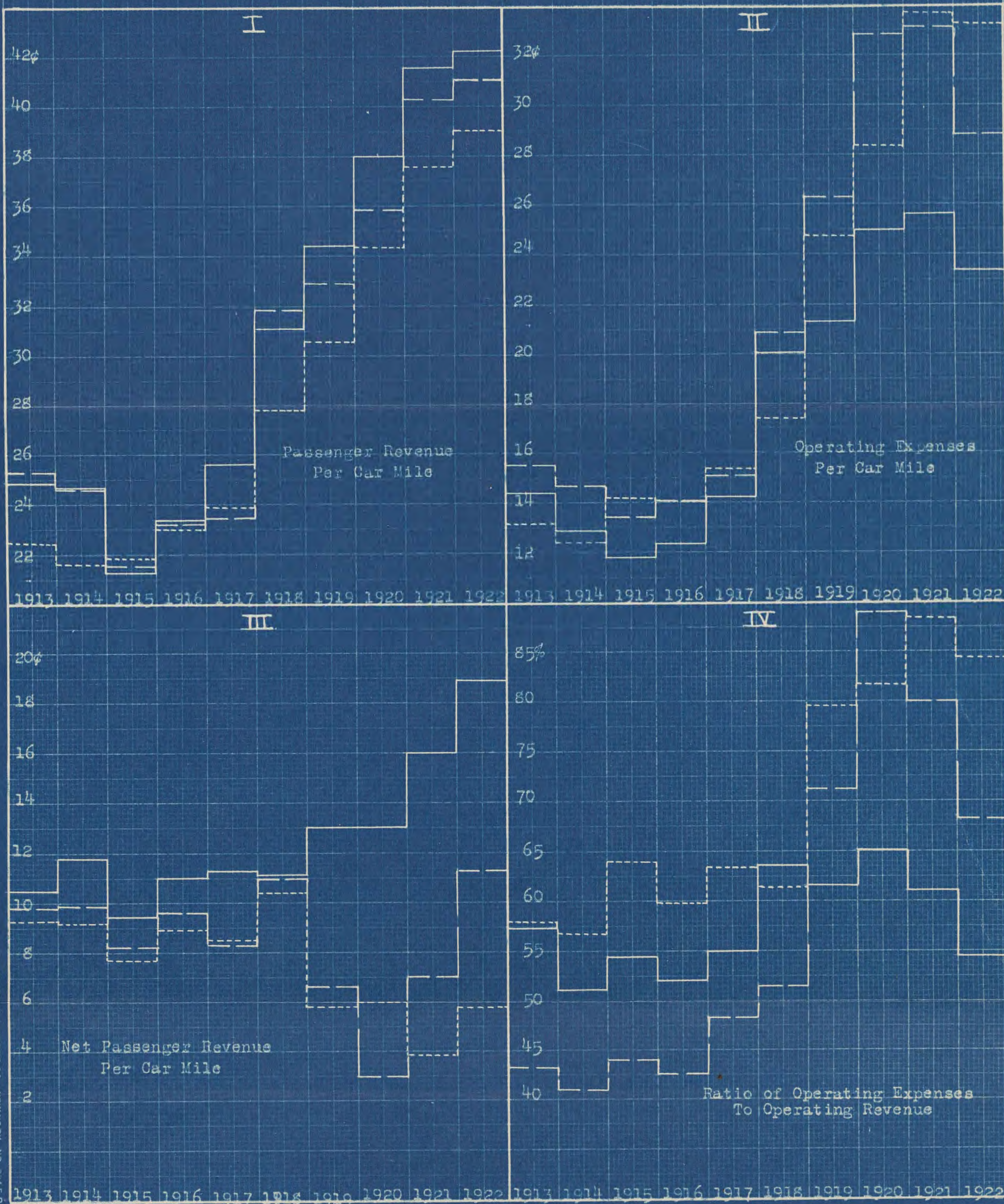


STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Memphis
Nashville
Knoxville

Legend

— Memphis
— Nashville
- - - Knoxville

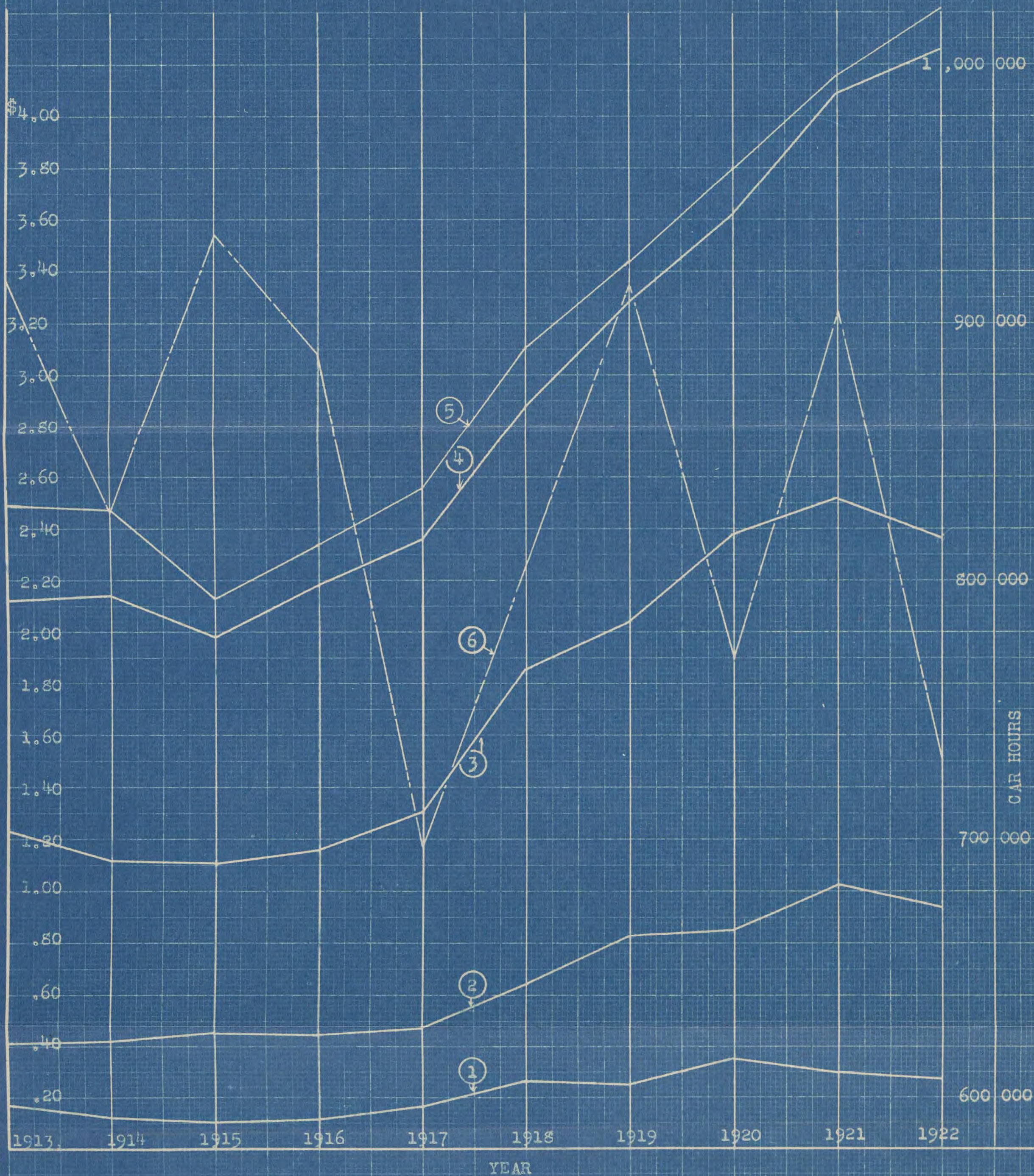


STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Car Hours, Passenger Revenue and Detailed
Operating Expenses per Car Hour.

Memphis

1. Power per car Hr.
2. M.&G. Wages Per Car Hr.
3. Operating Expenses Per Car Hr.
4. Passenger Revenue " " "
5. Passenger Revenue Per Car Mile X 10.
6. Car Hours.

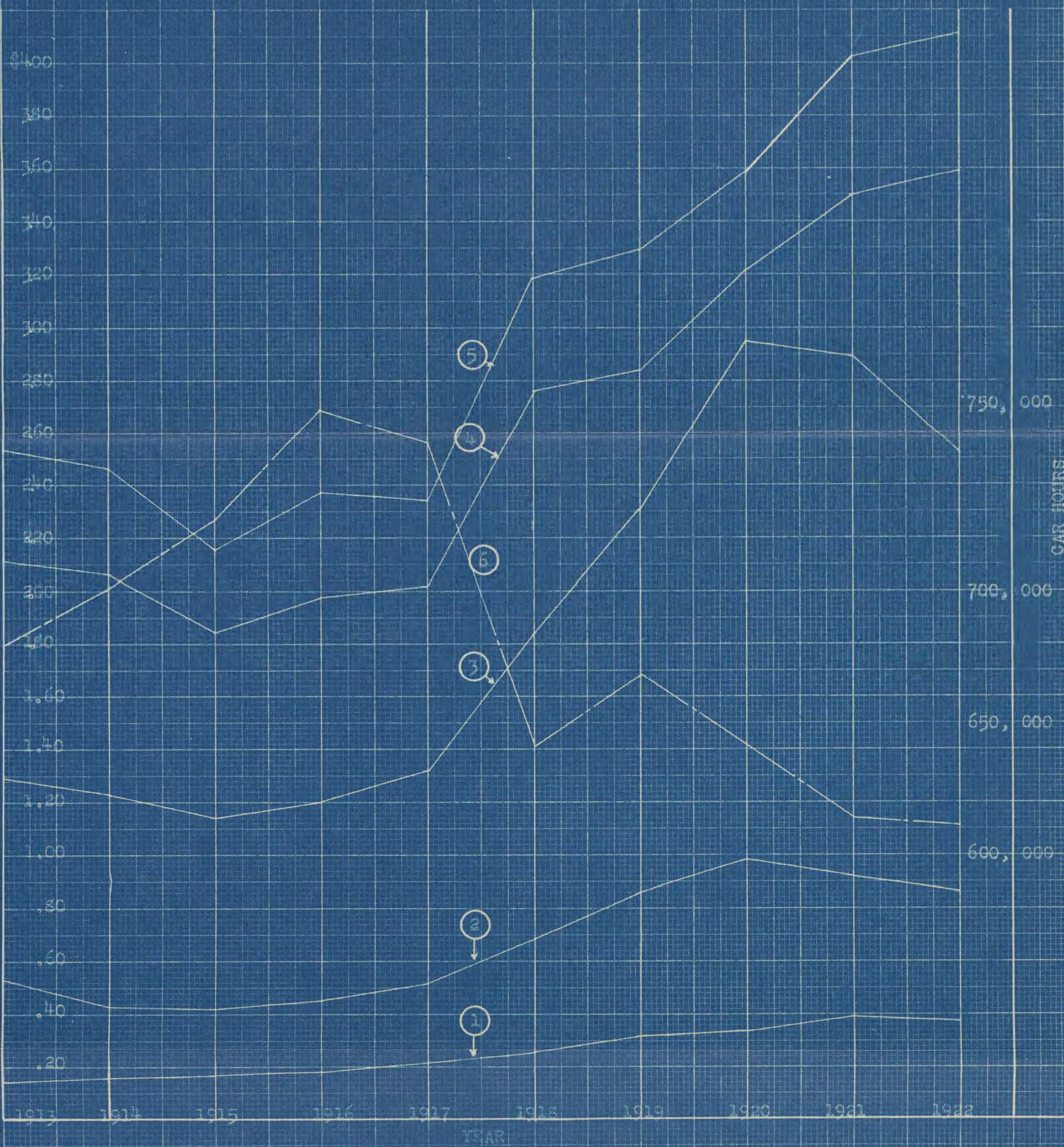


STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Car Hours, Passenger Revenue and Details of Operating Expenses Per Car Hour

Nashville

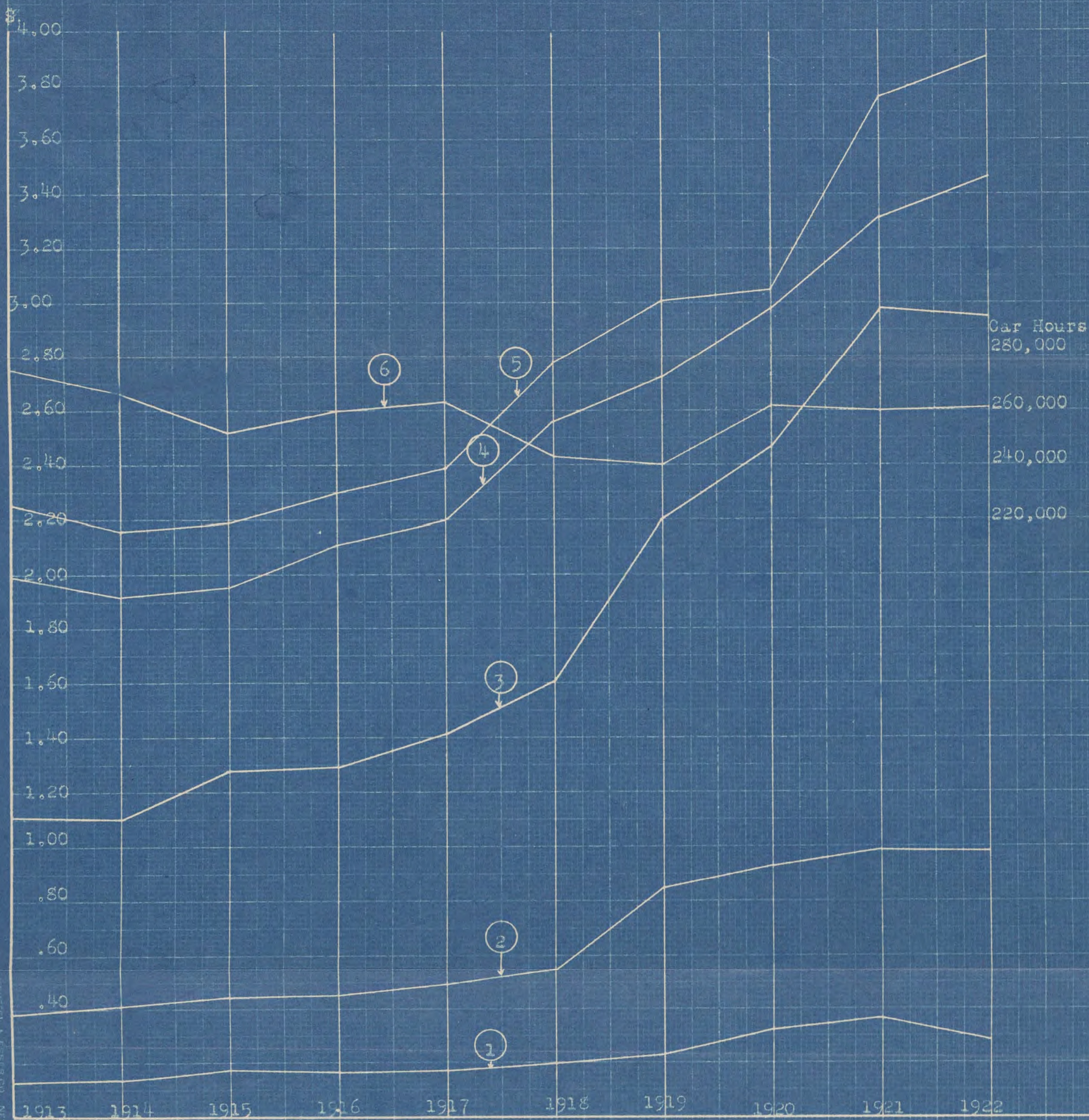
1. Power Per Car Hour
2. M. & C. Wages per car hour
3. Operating Expenses per car hour
4. Passenger Revenue per car hour
5. Passenger Revenue per car mile X 10.
6. Car Hours.



STUDY OF OPERATING EFFICIENCY Of STREET RAILWAYS OF TENNESSEE

Analysis of Car Hours, Passenger Revenue and
Detailed Operating Expenses
per car Hour.
Knoxville

1. Power - Per Car Hr.
2. M. & C. Wages " " "
3. Operating Expenses " " "
4. Passenger Revenue " " "
5. Passenger Revenue per Car Mile X 10.
6. Car Hours



OPERATING EFFICIENCY OF STREET RAILWAYS OF TENNESSEE

Legend

Memphis
Nashville
Knoxville

400,000

4,000

Total Taxes

Taxes per Mile Track

300,000

3,000

200,000

2,000

100,000

1,000

1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922

5,000

Total Maintenance Per Mile Track

500,000

Total Maintenance

4,000

400,000

3,000

300,000

2,000

200,000

1,000

100,000

1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922

SPEED AS RELATED TO OPERATING EFFICIENCY

The speed of a car is a vital factor in economy. By speed we mean average hourly speed for a day, week, month or year.

Renewal and Replacement Charges, Taxes, and Maintenance are continuous charges. Platform Wages are continuous throughout the operating period. But the revenue is available only when cars are passing loading points. Thus it is seen that the more cars running per hour and the more miles per hour run by individual cars, the greater will be the service as well as the revenue derived therefrom.

Memphis shows in 1922 a speed of 10.1 miles per hour, Sheets 31, 32 and 33, an increase of .9 miles per hour over 1917. A glance at the Memphis sheet, 31, shows an increase of Operating Revenue from \$2.35 per car hour to \$4.20 per car hour, an increase of 79%, while the operating expense per car hour for the same period increases from \$1.30 to \$2.38 or 83.1%. From the figure it would appear that expenses were increasing at a more rapid rate than revenue. When we consider, however, the increase in platform wages as a percentage of operating expenses (See Sheet 15), the effect of the speed is seen in a reduction of cost per car mile to a point below what would have obtained had the car not speeded up.

TAXATION AND MAINTENANCE

The consideration of taxes and maintenance for the period 1913-1922 shows that both increased in less proportion than the general rise of prices as given in the conspectus of indexes (see Curve Sheet 2b), however, they did follow the same general trend, i. e. they dropped off slightly after 1913 and then tended to rise. The maintenance dropped again after 1920 which was the year of maximum prices. On the other hand, the taxes increased each year after a slight decrease in some instances for the year or two just after 1913. This was due, doubtlessly, to the fact that the government had incurred a large indebtedness during the world war and necessarily had to continue to increase taxes for purposes of revenue.

The curve "Total maintenance per mile track" shows that item to be largest for Memphis and smallest for Knoxville. This would seem to indicate that the standard of service is lower for Knoxville than for Memphis, because a larger maintenance per mile track means better tracks and equipment.

Methods of Charging off Depreciation.

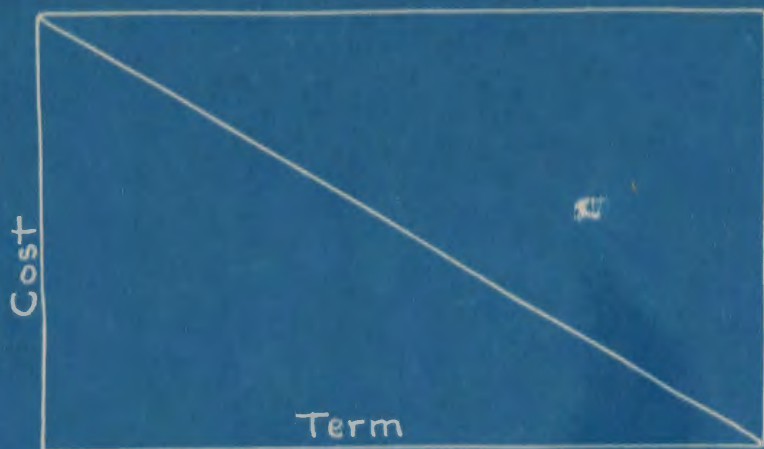


Fig. A

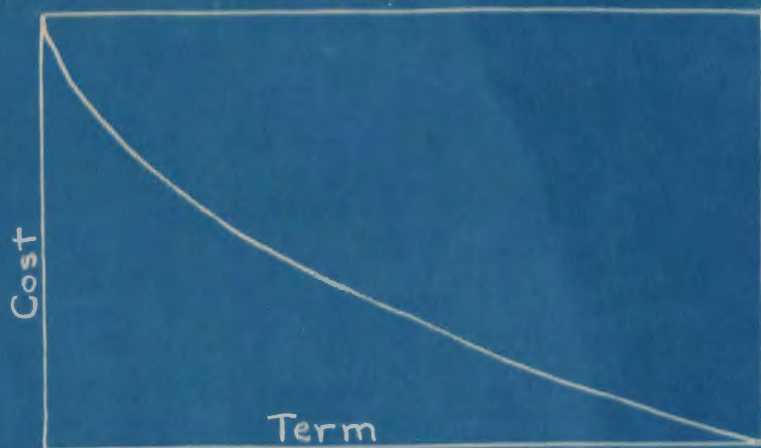


Fig. B

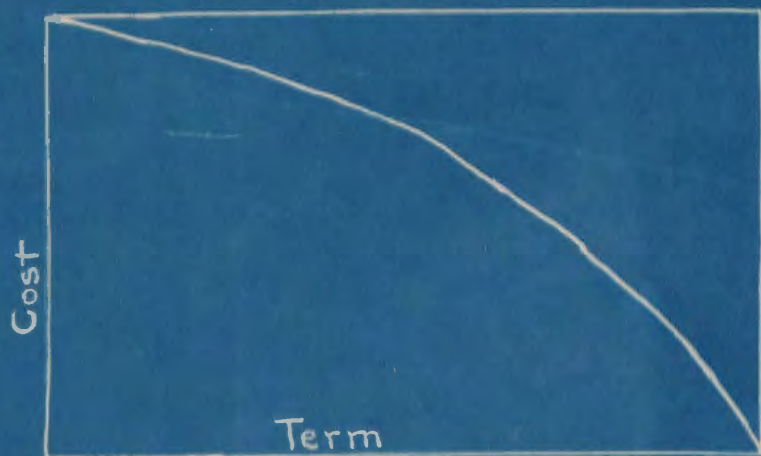


Fig. C

DATA FOR SHEET NO. 1

RIDING HABIT

	Memphis	Nashville	Knoxville
1913	247	230	152
1914	242	225	140
1915	197	210	132
1916	241	230	142
1917	242	227	144
1918	228	265	152
1919	264	285	155
1920	280	255	182
1921	290	285	179
1922	299	290	176

DATA FOR SHEET NO. 2

(See Sheet # 2d for Source)

DATA FOR SHEET NO. 2a

(See Data for Curve III, Sheet 34)

DATA FOR SHEET NO. 2b

(See Sheet #2d for Source)

	St. R. W. Fares for State	Index Numbers
1913	4.91	100
1914	4.94	101
1915	4.96	101
1916	4.94	101
1917	4.97	101
1918	5.00	102
1919	5.24	107
1920	6.11	125
1921	6.64	135
1922	6.83	139

DATA FOR SHEET NO. 2c

MOTORMEN & CONDUCTORS WAGES
CENTS PER HR.

	Memphis	Nashville	Knoxville	Chattanooga
1913	25	22	23	23.5
1914	26	22	24	23.5
1915	26	22	25	23.5
1916	26	23	25	25
1917	28	26	27	27
1918	28	30	28	33
1919	38	40	40	42
1920	48	48	40	46
1921	57	55	47	50
1922	53	48	47	46

	Weighted Average	Index Figure
1913	23.6	100
1914	24.0	101.8
1915	24.0	101.8
1916	24.7	104.5
1917	27.1	114.9
1918	30.3	128.5
1919	39.6	168.0
1920	46.6	197.5
1921	54.0	229.0
1922	49.7	210.5

NO. OF MEN EMPLOYED

	Memphis	Nashville	Knoxville	Chattanooga
1913	544	455	145	225
1914	565	475	156	205
1915	505	456	122	210
1916	581	458	141	215
1917	581	478	138	197
1918	499	437	131	208
1919	513	453	169	202
1920	622	459	188	205
1921	568	390	188	167
1922	540	400	164	167

DATA FOR SHEET NO. 3

Car Miles Per Revenue Passenger

	Memphis	Nashville	Knoxville	Chattanooga
1913	.200	.197	.223	.208
1914	.202	.203	.231	.227
1915	.234	.231	.227	.225
1916	.209	.214	.216	.205
1917	.194	.214	.208	.182
1918	.160	.157	.178	.159
1919	.161	.152	.162	.151
1920	.167	.169	.145	.171
1921	.167	.168	.145	.162
1922	.165	.170	.153	.171

DATA FOR SHEET #5.

Memphis

	Power	Maintenance	Traffic & General	Conducting Transportation
1913	149,517	275,252	269,988	473,864
1914	108,865	176,528	254,554	485,243
1915	86,689	146,563	219,474	460,497
1916	109,461	180,522	272,396	521,820
1917	153,811	200,828	281,825	530,157
1918	186,343	237,308	312,002	562,376
1919	199,035	306,490	330,502	815,184
1920	329,261	405,349	387,344	1,057,479
1921	229,196	387,625	349,378	977,754
1922	200,263	325,655	323,413	873,816

DATA FOR SHEET #5 (Cont'd)

Memphis

	Total Opr. Ex.	R. & R. Accrual	Taxes	Total cost of Service	Total Operating Revenue
1913	1,114,900	53,721	127,644	1,296,265	1,937,308
1914	1,025,191	83,330	138,093	1,246,614	1,998,913
1915	913,218	21,280	133,841	1,068,339	1,678,435
1916	1,084,200	321,716	132,732	1,538,468	2,078,745
1917	1,166,622	275,198	155,738	1,597,558	2,126,645
1918	1,298,030	169,557	157,485	1,625,072	2,034,325
1919	1,651,212	228,531	177,785	2,057,528	2,675,110
1920	2,180,434	230,237	267,119	2,677,790	3,342,213
1921	1,943,454	232,098	293,000	2,468,552	3,181,246

DATA FOR CURVE SHEET #6.

	Power	Maint.	Nashville Traf. & Gen.	Cond. Trans.	Total Opr. Expenses.
1913	101,007	243,482	172,218	363,134	879,841
1914	112,458	200,505	186,876	362,910	862,749
1915	122,816	152,624	186,329	355,883	827,652
1916	131,944	135,851	227,462	405,353	900,610
1917	151,707	163,681	210,168	450,847	976,403
1918	162,730	221,766	301,107	507,972	1,193,575
1919	211,612	347,901	308,455	703,558	1,571,526
1920	219,003	464,325	406,000	805,248	1,894,577
1921	237,755	442,227	399,886	693,012	1,772,880
1922	223,682	380,129	295,216	641,665	1,540,093

DATA FOR CURVE SHEET #6 (cont'd)

	R. & R. Accrual	Taxes.	Total cost of Service	Total Oper. Revenue.
1913	21,931	138,391	1,040,163	2,029,019
1914	30,000	144,797	1,037,546	2,050,412
1915	100,703	150,080	1,078,435	1,879,899
1916	60,000	158,410	1,119,021	2,110,975
1917	172,500	161,589	1,310,492	2,019,421
1918	311,030	185,069	1,689,674	2,321,825
1919	185,000	203,106	1,959,632	2,269,009
1920	294,000	283,019	2,471,596	2,129,525
1921	247,737	308,859	2,329,476	2,214,145
1922	253,025	323,388	2,116,506	2,255,367

DATA FOR CURVE SHEET #7

DATA FOR CURVE SHEET #8.

Memphis per Rev. Passenger ¢

	Power	Mant.	Traf.	Condt.	Opr.	R. & R.	Taxes	Totl.	Pass.
			Gen.	Tran.	Ex.	Aorl.		Cost	Revenue.
1913	0.39	0.57	0.68	1.23	2.87	0.14	0.33	3.34	4.97
1914	0.28	0.25	0.64	1.23	2.60	0.21	0.35	3.16	4.98
1915	0.25	0.45	0.67	1.40	2.78	0.06	0.41	3.25	5.00
1916	0.26	0.45	0.67	1.23	2.56	0.77	0.32	3.65	4.85
1917	0.37	0.48	0.67	1.26	2.78	0.66	0.37	3.81	4.98
1918	0.46	0.59	0.777	1.39	3.21	0.42	0.39	4.02	4.99
1919	0.42	0.64	0.69	1.70	3.45	0.38	0.37	4.20	5.55
1920	0.63	0.77	0.74	2.02	4.16	0.44	0.51	5.11	6.33
1921	0.50	0.85	0.77	2.15	4.27	0.51	0.64	5.42	6.93
1922	0.45	0.73	0.73	1.96	3.87	0.64	0.72	5.23	7.00

DATA FOR CURVE SHEET #9

Nashville Per Revenue Passenger ¢

1913	0.36	0.86	0.60	1.28	3.10	0.07	0.48	3.65	5.00
1914	0.38	0.68	0.64	1.24	2.94	0.10	0.50	3.54	5.00
1915	0.46	0.58	0.69	1.36	3.09	0.37	0.56	4.02	5.00
1916	0.46	0.46	0.79	1.39	3.10	0.20	0.53	3.84	5.00
1917	0.53	0.57	0.66	1.56	3.32	0.58	0.54	4.44	5.00
1918	0.48	0.64	0.83	1.49	3.44	0.89	0.53	4.86	5.00
1919	0.56	1.00	0.72	1.83	4.11	0.49	0.54	5.14	5.00
1920	0.64	1.37	1.19	2.36	5.56	0.87	0.83	7.26	6.08
1921	0.75	1.39	1.26	2.18	5.58	0.78	0.97	7.33	6.77
1922	0.71	1.21	0.94	2.05	4.91	0.81	1.05	6.75	7.00

DATA FOR SHEET #10

	Power	Maint.	Tr&Gen.	Con.Tr.	Opr Exp.	R.&R. Accrual	Taxes	Total	Pass. Rev.
1913	0.36	0.61	0.73	1.37	3.07	0.03	0.24	3.34	5.03
1914	0.35	0.32	0.77	1.33	2.77	0.19	0.25	3.21	4.99
1915	0.44	0.42	1.00	1.38	3.24	0.18	0.32	3.74	4.98
1916	0.38	0.27	0.95	1.31	2.91	0.20	0.28	3.39	4.98
1917	0.39	0.51	0.94	1.37	3.21	0.09	0.40	3.70	4.99
1918	0.38	0.51	0.91	1.32	3.12	0.15	0.36	3.63	4.98
1919	0.41	0.71	0.87	2.02	4.01	0.60	0.35	4.96	4.97
1920	0.53	0.88	0.83	1.87	4.11	0.22	0.42	4.75	4.97
1921	0.60	1.16	1.19	1.93	4.88	0.32	0.60	5.80	5.46
1922	0.49	1.38	1.23	2.01	5.11	0.47	0.47	6.05	6.00

MEMPHIS

DATA FOR CURVE SHEET #11. ¢ PER CAR MILE.

	Power	Maint.	Tr. Gen.	Cond. Trans.	Opr. Exp.	R&R. Accrual	Taxes	Total cost.	Pass. Ser. Rev.
1913	1.94	2.88	3.38	6.17	14.37	.70	1.66	16.73	24.90
1914	1.37	2.21	3.19	6.09	12.86	1.04	1.73	15.63	24.68
1915	1.12	1.90	2.85	5.98	11.85	0.27	1.74	13.86	21.30
1916	1.25	2.02	3.13	5.95	12.35	3.69	1.52	17.56	23.40
1917	1.88	2.45	3.45	6.48	14.26	3.37	1.90	19.53	25.60
1918	2.88	3.66	4.83	8.69	20.06	2.62	2.43	25.11	31.14
1919	2.57	3.96	4.28	10.54	21.35	2.95	2.30	26.61	34.36
1920	3.77	4.64	4.44	12.10	24.95	2.64	3.06	30.65	37.98
1921	3.01	5.09	4.60	12.89	25.59	3.06	3.86	32.51	41.55
1922	2.72	4.42	4.39	11.85	23.38	3.86	4.32	31.56	42.20

DATA FOR CURVE SHEET #12.

¢ PER CAR MILE NASHVILLE.

	Power	Main.	Tr. Gen.	Cond. Trans.	Opr. Exp.	R&R Accrual	Taxes	Total cost.	Pass. Ser. Rev.
1913	1.80	4.30	3.00	6.40	15.50	.35	2.42	18.27	25.30
1914	1.90	3.40	3.20	6.20	14.70	.49	2.40	17.59	24.60
1915	2.00	2.50	3.00	5.90	13.40	1.60	2.42	17.42	21.60
1916	2.10	2.10	3.60	6.30	14.10	.93	2.46	17.49	23.70
1917	2.40	2.60	3.00	7.10	15.10	2.65	2.51	20.26	23.40
1918	3.00	3.40	5.20	9.30	20.90	5.83	3.47	30.20	31.90
1919	3.70	5.60	4.80	12.20	26.30	3.21	3.53	33.04	32.90
1920	3.80	8.08	7.02	13.90	32.80	5.13	4.89	42.82	35.80
1921	4.50	8.26	7.48	12.90	33.14	4.68	5.75	43.57	40.20
1922	4.16	7.10	5.51	12.00	28.77	4.70	6.04	39.51	41.10

DATA FOR SHEET #13

CENT PER CAR MILE - KNOXVILLE

	Power	Mainten- ance	Trf. & Gen.	Conduct Trans.	Opr. Exp.
1913	1.60	2.73	3.19	5.81	13.33
1914	1.52	1.81	3.34	5.73	12.40
1915	1.92	2.02	4.39	6.03	14.36
1916	1.74	2.74	4.39	6.07	14.94
1917	1.86	3.27	4.52	6.57	16.22
1918	2.13	3.98	5.08	7.37	18.56
1919	2.55	4.44	5.37	12.45	24.81
1920	3.68	6.07	5.74	12.95	28.44
1921	4.12	8.25	8.23	13.33	33.93
1922	3.22	9.04	8.02	13.11	33.39

	R. & R. Accrual	Total cost of Service	Passgr. Revenue.	Taxes.
1913	0.13	14.53	22.50	1.07
1914	0.80	14.28	21.60	1.08
1915	1.81	16.58	21.90	1.41
1916	0.93	17.16	23.00	1.29
1917	0.44	18.58	23.90	1.92
1918	0.84	21.42	27.80	2.02
1919	3.67	30.62	30.60	2.14
1920	1.53	32.87	34.50	2.90
1921	2.18	40.14	37.60	4.13
1922	3.04	41.47	39.10	5.04

DATE FOR CURVE SHEET #14.

% OPERATING EXPENSE - MEMPHIS -

	Power	Mainten- ance	Trf. & Gen.	Conduct Trans.	Total Opr. Exp.
1913	13.5	20.1	23.5	42.9	100.0
1914	10.6	17.1	24.8	47.3	100.0
1915	9.6	16.0	24.0	50.4	100.0
1916	10.1	16.4	25.4	48.1	100.0
1917	13.2	17.2	24.2	45.4	100.0
1918	14.3	18.2	24.2	43.3	100.0
1919	12.1	18.2	20.4	49.3	100.0
1920	15.2	18.6	17.8	48.4	100.0
1921	11.7	19.9	18.1	50.3	100.0
1922	11.6	18.9	18.8	50.7	100.0

DATA FOR CURVE SHEET #15

% OPERATING EXPENSE - NASHVILLE

	Power	Mainten- ance	Trf. & Gen.	Conduct- Trans.	Total Opr. Exp.
1913	11.4	27.6	19.5	41.5	100.0
1914	13.1	23.2	21.7	42.0	100.0
1915	14.8	18.5	22.5	44.2	100.0
1916	14.6	15.0	25.3	45.1	100.0
1917	15.5	16.7	21.5	46.3	100.0
1918	13.6	18.6	25.2	42.6	100.0
1919	13.4	22.3	19.0	45.3	100.0
1920	11.8	23.7	21.7	42.8	100.0
1921	13.4	25.0	22.5	39.1	100.0
1922	14.5	24.6	19.3	41.6	100.0

DATA FOR CURVE SHEET #16

	Power	Mainten- ance Opr.Exp.	Trf. & Gen.	Conduct- ing Trans.	Total Opr. Exp.
1913	12.10	20.00	24.00	43.00	100.00
1914	12.20	14.50	26.90	46.40	100.00
1915	13.20	21.40	30.90	43.50	100.00
1916	12.40	12.40	31.20	44.00	100.00
1917	12.00	16.00	29.00	43.00	100.00
1918	12.30	16.30	29.10	42.30	100.00
1919	10.20	17.60	21.60	50.60	100.00
1920	12.90	21.30	20.30	45.50	100.00
1921	12.30	23.80	24.40	39.50	100.00
1922	9.90	26.10	24.60	39.40	100.00

DATA FOR CURVE SHEET #17 -MEMPHIS

% OPERATING REVENUE -

	Power	Mainten- ance	Trf. & Gen.	Conducting Transpt.	Opr. Exp.
1913	7.8	11.6	13.5	24.7	57.6
1914	5.4	8.8	12.7	24.2	51.1
1915	5.2	8.7	13.1	27.4	54.4
1916	5.3	8.5	13.2	25.1	52.1
1917	7.2	9.4	13.3	24.9	54.8
1918	9.1	11.6	15.4	27.6	63.7
1919	7.4	11.2	12.6	30.4	61.6
1920	9.8	12.1	11.6	31.6	65.1
1921	7.1	12.3	11.0	30.7	61.1
1922	6.3	10.3	10.3	27.6	54.5

	R. & R. Annual	Taxes	Total cost of Service.
1913	2.8	6.6	67.0
1914	4.1	6.9	62.1
1915	1.2	8.0	63.6
1916	15.4	6.4	73.9
1917	12.9	7.3	75.0
1918	8.3	7.7	79.7
1919	8.5	6.6	76.7
1920	6.9	7.9	79.9
1921	7.8	9.2	78.1
1922	9.0	10.1	73.6

DATA FOR CURVE SHEET #18 - NASHVILLE

% OPERATING REVENUE.

	Power	Mainten- ance	TRAFFIC & Gen.	Conducting Transportation
1913	4.97	12.00	8.48	17.89
1914	5.48	9.78	9.11	17.69
1915	6.53	8.12	9.90	19.46
1916	6.25	6.43	10.77	19.20
1917	7.51	8.10	10.40	22.32
1918	7.00	9.55	12.96	21.87
1919	9.32	17.53	13.59	31.90
1920	10.28	21.79	19.08	37.81
1921	10.73	19.92	18.04	31.35
1922	9.92	16.87	13.11	28.42

	Oper. Exp.	R. & R. Accrual	Taxes	Total cost of service.
1913	43.34	1.08	6.82	51.24
1914	42.06	1.46	7.05	50.57
1915	44.01	5.35	7.98	57.34
1916	42.65	2.84	7.50	52.99
1917	48.33	8.54	8.00	64.87
1918	51.38	13.30	7.90	72.58
1919	71.44	8.15	8.80	88.49
1920	88.96	13.79	13.28	116.03
1921	80.04	11.21	13.95	105.20
1922	68.32	11.22	14.33	93.87

SHEET NUMBER 19

% OF OPERATING REVENUE - KNOXVILLE

	Power	Mainten- ance	Trf. & Gen	Cond. Trans.	Opr. Expense
1913	6.00	12.00	14.40	25.40	57.80
1914	6.90	8.33	15.33	26.20	56.76
1915	8.60	8.21	19.78	27.30	63.89
1916	7.40	8.03	18.72	25.80	59.95
1917	7.60	10.20	18.42	27.10	63.32
1918	7.60	10.03	18.04	26.00	61.67
1919	8.10	14.25	17.30	40.00	79.65
1920	10.60	17.46	16.64	37.30	82.00
1921	10.80	21.11	21.60	34.90	88.41
1922	8.10	22.83	21.00	33.10	85.03

	R. & R. Accrual	Taxes	Total Cost of Service	Total Opr. Revenue
1913	0.56	4.78	63.14	100.00
1914	3.66	4.94	65.36	100.00
1915	3.61	6.27	73.77	100.00
1916	3.96	5.56	68.47	100.00
1917	1.79	7.86	72.97	100.00
1918	2.95	6.99	71.61	100.00
1919	11.70	6.98	98.33	100.00
1920	4.83	8.32	95.15	100.00
1921	5.73	10.79	104.93	100.00
1922	7.70	12.77	105.50	100.00

DATA FOR CURVE SHEET #20

M E M P H I S

	Revenue Passengers	Car Miles	Car Miles per Rev. Pass.
1913	38,460,595	7,680,190	.200
1914	39,470,175	7,965,657	.202
1915	32,890,333	7,697,382	.234
1916	41,032,520	8,706,489	.207
1917	42,019,062	8,176,038	.194
1918	40,346,427	6,461,204	.164
1919	47,759,881	7,720,777	.161
1920	52,315,670	8,718,427	.167
1921	45,493,064	7,590,981	.167
1922	44,481,903	7,368,568	.165

DATA FOR CURVE SHEET #21

N A S H V I L L E

	Revenue Passengers	Car Miles	Car Miles Per Rev. Pass.
1913	28,659,285	5,669,161	.197
1914	28,724,072	5,847,318	.203
1915	26,654,589	6,177,065	.231
1916	29,683,428	6,381,538	.214
1917	29,491,857	6,328,469	.214
1918	34,648,080	5,447,592	.157
1919	37,763,867	5,765,039	.152
1920	33,978,322	5,763,019	.169
1921	31,747,176	5,338,128	.168
1922	31,314,479	5,341,612	.170

SHEET #22a.

Volume
~~Time~~ of Business.

	Memphis	Nashville	Knoxville	Chattanooga.
1913	38,460,595	28,659,285	10,891,542	14,543,719
1914	39,470,175	28,724,072	10,255,201	13,237,402
1915	32,890,333	26,654,589	9,976,243	12,828,035
1916	41,032,520	29,683,428	11,052,841	14,418,766
1917	42,019,182	29,491,857	11,586,933	14,127,372
1918	40,346,427	34,648,080	12,543,307	17,285,852
1919	47,759,881	37,763,867	13,127,748	17,179,684
1920	52,315,670	33,978,322	15,729,604	16,413,649
1921	45,493,064	31,747,176	15,743,041	14,375,703
1922	44,481,903	31,314,497	15,067,837	13,951,106

DATA USED FOR CURVE SHEET #22.

	Rev. Passengers	Car Miles.	Total cost of Serv.
1913	10,891,542	2,429,381	223
1914	10,255,201	2,369,246	231
1915	9,976,243	2,265,908	227
1916	11,056,841	2,391,573	216
1917	11,586,933	2,412,877	208
1918	12,546,307	2,247,794	178
1919,	13,127,748	2,134,875	162
1920	15,729,604	2,273,308	145
1921	15,743,935	2,284,935	145
1922	15,067,831	2,308,860	153

DATA For ^{Curve} ~~CURVE~~ SHEET #23

Ia R.R.R. Accrual.

	Memphis	Nashville	Knoxville
1913	53,721	21,931	3,097
1914	83,330	30,000	4,989
1915	21,280	100,703	18,191
1916	321,716	60,000	22,326
1917	275,198	172,500	10,491
1918	169,557	311,030	18,803
1919	228,531	185,000	78,179
1920	230,237	294,000	34,696
1921	232,098-	247,737	49,446
1922	284,705	253,025	70,303

Ib R.R.R. Payment

1913,	242,964	127,278	188,78
1914	91,126	130,164	712,49
1915	8,504	102,311	258,98
1916	57,261	146,582	877,94
1917	33,600	89,167	309,02
1918	,20,125	6,845	188,04
1919	119,42	68,255	390,10
1920	178,287	87,716	105,00
1921	186,464	112,411	874,50
1922	182,439	94,124	857,35

CURVE
~~CURRENT~~ SHEET #23 (Cont'd.)

IIa I ⁸ D. Reserve

	Memphis	Nashville	Knoxville
1913,	199,800	91,169	48,100
1914	182,000	91,169	3,749
1915	134,274	73,892	50,000
1916	166,300	82,451	71,526
1917	170,100	45,172	102,184
1918	203,400	82,344	111,576
1919	239,000	75,275	127,165
1920	272,900	154,000	125,484
1921	222,800	208,000	77,842
1922	204,800	132,000	111,321

IIb I ⁸ D Payment.

	Memphis	Nashville	Knoxville
1913	195,075	75,877	48,523
1914	192,581	83,918	57,810
1915	139,836	119,885	38,601
1916	218,243	75,290	29,341
1917	206,106	81,876	50,609
1918	183,907	121,397	44,411
1919	123,615	143,817	61,681
1920	328,175	153,354	101,062
1921	244,871	200,759	173,112
1922	197,483	139,698	57,182

DATA FOR CURVE SHEET #25

Operating Revenue	Passenger Revenue	Total Cost of Service
1913 1,937,580	1,917,009	1,296,265
1914 1,998,913	1,966,639	1,246,614
1915 1,678,435	1,640,168	1,068,339
1916 2,078,745	2,045,975	1,538,648
1917 2,126,645	2,095,067	1,597,558
1918 2,034,325	2,012,627	1,625,072
1919 2,675,110	2,653,405	2,057,528
1920 3,342,213	3,311,397	2,677,790
1921 3,181,246	3,154,724	2,468,552
1922 3,153,195	3,113,733	2,325,853

DATA FOR CURVE SHEET #26

NASHVILLE - DOLLARS

Operating Revenue	Passenger Revenue	Total Cost of Service
1913 2,029,019	1,434,389	1,040,163
1914 2,050,412	1,439,080	1,037,501
1915 1,879,899	1,335,217	1,078,437
1916 2,110,975	1,486,693	1,119,021
1917 2,019,421	1,482,867	1,310,493
1918 2,321,825	1,740,672	1,689,675
1919 2,269,009	1,897,172	1,959,632
1920 2,129,525	2,066,225	2,471,596
1921 2,214,145	2,148,608	2,329,476
1922 2,255,367	2,192,015	2,116,506

DATA FOR CURVE SHEET #27

KNOXVILLE - DOLLARS

Operating Revenue	Passenger Revenue	Total Cost of Service
1913 - 554,254	547,881	351,300
1914 517,475	511,977	338,911
1915 503,599	496,604	372,141
1916 563,369	551,120	387,088
1917 585,250	577,430	428,695
1918 636,910	625,687	455,306
1919 663,999	653,744	653,552
1920 790,834	782,460	747,523
1921 870,842	859,782	914,660
1922 912,961	904,499	957,681

I-KWH per Car Mile

GENERAL SHEET #28

Memphis	Nashville	Knoxville
1913 3.02	3.36	2.50
1914 3.11	3.65	2.60
1915 3.35	3.60	2.70
1916 3.67	3.75	2.37
1917 3.73	3.84	2.43
1918 3.73	3.85	2.56
1919 3.43	3.92	3.12
1920 3.52	3.81	3.81
1921 3.28	3.96	3.68
1922 3.99	4.10	3.74

II - Cost Power per KWH ¢

Memphis	Nashville	Knoxville
1913 .64	.53	.55
1914 .44	.53	.58
1915 .33	.55	.71
1916 .53	.56	.74
1917 .50	.62	.77
1918 .77	.78	.83
1919 .75	.93	.81
1920 1.07	1.00	.97
1921 .92	1.13	1.11
1922 .68	1.02	.86

III - KWH per Car Hour

Memphis	Nashville	Knoxville
1913 25.7	28.1	22.1
1914 27.0	30.4	23.1
1915 31.6	30.6	24.2
1916 34.1	31.2	21.8
1917 34.3	33.1	22.3
1918 34.5	33.3	23.7
1919 32.8	33.8	27.7
1920 33.6	34.2	33.0
1921 32.3	34.4	32.8
1922 40.2	36.0	33.1

General Sheet #28 (Cont'd)

IV Speed Miles per Hr.

	Memphis	Nashville	Knoxville
1913	8.5	8.3	8.8
1914	8.7	8.3-	8.9
1915	9.3	8.5	9.0
1916	9.3	8.5-	9.2
1917	9.2	8.6	9.2
1918	9.4	8.6	9.2
1919	9.6	8.6	8.9
1920	9.5	8.0	8.7
1921	9.9	8.7	8.8
1922	10.1	8.8	8.8

Sheet #29.

I - Max ^{ou} Early Platform

Wages Paid on June 30. ¢

	Memphis	Nashville	Knoxville	Chattanooga.
1913	25	22	23	23.5
1914	26	22	24	23.5
1915	26	22	25	23.5
1916	26	23	25	25.0
1917	28	26-	27	27.0
1918	28	30	28	38.0
1919	38	40	40	42.0
1920	48	48	40	46.0
1921	57	55	47	50.0
1922	53	48	47	46.0

II - Total Maintenance ² to Operating Revenue. %

	Memphis	Nashville	Knoxville
1913	11.6	12.0	12.0
1914	8.8	9.8	8.3
1915	8.7	8.1	8.2
1916	8.5	6.4	8.0
1917	9.4	8.1	10.2
1918	11.6	9.6	10.0
1919	11.2	17.5	14.3
1920	12.1	21.8	17.5
1921	12.3	19.9	21.1
1922	10.3	16.9	22.8

Sheet #29 (Cont'd)

III. o/e Taxes to
Operating Revenue.

	Memphis	Nashville	Knoxville
1913	6.6	6.8	4.8
1914	6.9	7.1	4.9
1915	8.0	8.0	6.3
1916	6.4	7.5	5.6
1917	7.3	8.0	7.9
1918	7.7	7.9	7.0
1919	6.6	8.9	7.0
1920	7.9	13.3	8.3
1921	9.2	14.0	10.8
1922	10.1	14.3	12.8

IV. % Injuries & Damage
Payment Opr. Rev.

	Memphis	Nashville	Knoxville
1913	10.0	3.6	8.8
1914	9.6	4.1	11.2
1915	8.4	6.4	7.7
1916	10.5	3.6	5.2
1917	9.7	4.1	8.7
1918	9.0	5.2	7.0
1919	4.6	6.6	9.3
1920	9.8	7.2	12.8
1921	7.7	9.0	8.4
1922	6.3	6.2	6.3

I - Passenger Revenue
Per Car Mile ¢

CURVES #30.

	Memphis	Nashville	Knoxville
1913	24.90	25.30	22.50
1914	24.68	24.60	21.60
1915	21.30	21.60	21.90
1916	23.40	23.70	23.00
1917	25.60	23.40	23.90
1918	31.14	31.90	27.80
1918	34.36	32.90	30.60
1920	37.98	35.80	34.40
1921	41.55	40.20	37.60
1922	42.20	41.10	39.10

CURVES #30 (Cont'd)

II- Operating Expenses
Per car mile ¢

	Memphis	Nashville	Knoxville
1913	14.37	15.50	13.33
1914	12.86	14.70	12.40
1915	11.85	13.40	14.36
1916	12.35	14.10	14.94
1917	14.26	15.10	16.22
1918	20.06	20.90	18.56
1919	21.35	26.30	25.67
1920	34.95	32.80	29.97
1921	25.59	33.14	33.93
1922	23.38	28.77	31.66

III - Net Passenger Revenue
Per Car Mile ¢

	Memphis	Nashville	Knoxville
1913	10.53	9.80	9.17
1914	11.82	9.90	9.20
1915	9.45	8.20	7.54
1916	11.05	9.60	8.06
1917	11.34	8.30	7.68
1918	11.08	11.00	9.24
1919	13.01	6.60	4.93
1920	3.03	3.00	4.43
1921	15.96	7.06	3.67
1922	18.82	12.33	7.44

IV.- Operating Ratio%
Operating Exp.
" Rev.

	Memphis	Nashville	Knoxville
1913	57.6	43.34	58.00
1914	51.1	42.06	56.80
1915	54.4	44.01	64.00
1916	52.1	42.65	59.80
1917	54.8	48.33	63.50
1918	63.7	51.38	61.50
1919	61.6	71.44	79.70
1920	65.1	88.96	81.80
1921	61.1	80.04	88.50
1922	54.5	68.32	84.40

DATA FOR CURVE SHEET #31.

\$ per Car Hour - Memphis

Power	Platfm. Wages	Opr. Exp.	Passgr. Rev.	Pass Rev. per car mi. <i>X 10</i>	Car Hours.
1913 .17	.41	1.23	2.12	2.49	904,067
1914 .12	.42	1.12	2.14	2.47	917,260
1915 .10	.45	1.11	1.98	2.13	826,176
1916 .12	.45	1.16	2.18	2.34	934,611
1917 .17	.48	1.31	2.36	2.56	888,440
1918 .27	.65	1.86	2.88	3.11	697,785
1919 .25	.83	2.04	3.28	3.44	807,884
1920 .36	.85	2.38	3.62	3.80	915,221
1921 .30	1.13	2.52	4.09	4.16	770,979
1922 .27	.94	2.36	4.26	4.22	730,122

DATA FOR CURVE SHEET #32.

\$ per Car Hour - Nashville

Power	Platform Wages	Oper. Exp.	Passgr. Rev.	Pass.Rev.per car Mile x 10	Car Hours
1913 .15	.53	1.29	2.11	2.53	679,968
1914 .16	.42	1.23	2.06	2.46	701,580
1915 .17	.42	1.14	1.84	2.16	727,148
1916 .18	.45	1.20	1.98	2.37	749,356
1917 .21	.52	1.32	2.02	2.34	736,101
1918 .26	.68	1.84	2.76	3.19	631,241
1919 .32	.86	2.30	2.84	3.29	668,508
1920 .34	.98	2.95	3.22	3.58	642,383
1921 .39	.92	2.89	3.50	4.02	613,987
1922 .365	.86	2.52	3.59	4.11	610,756

DATA FOR SHEET #33.

Per Car Hour - Knoxville

Power	Platfm. Wages	Opr. Exp.	Passgr. Rev.	Pass. Rev. per Car Mi. x 10	Car Hours.
1913 12.10	38.40	1.170	1.990	2.25	275,258
1914 13.40	40.90	1.105	1.92	2.16	266,395
1915 17.20	44.80	1.275	1.96	2.19	252,749
1916 16.10	45.70	1.296	2.12	2.30	260,312
1917 17.10	49.50	1.415	2.20	2.39	262,923
1918 19.70	55.10	1.611	2.57	2.78	243,109
1919 22.50	85.40	2.208	2.73	3.06	239,817
1920 32.00	93.20	2.467	2.98	3.44	262,267
1921 36.40	98.40	2.925	3.32	3.76	259,025
1922 28.50	98.10	2.949	3.47	3.91	261,264

GENERAL SHEET #34

I - Total Taxes \$

	Memphis	Nashville	Knoxville
1913	127644	138391	26500
1914	138093	144797	25600
1915	133841	150080	31600
1916	132732	158410	31350
1917	155735	161589	46000
1918	157485	185069	44750
1919	177785	203107	45650
1920	267119	283019	65800
1921	293000	308859	94000
1922	318000	323388	116750

II - Taxes per mile of track. \$

	Memphis	Nashville	Knoxville
1913	1030	1640	484
1914	1100	1475	467
1915	1175	1485	577
1916	1068	1565	572
1917	1243	1640	840
1918	1253	1850	817
1919	1420	1990	834
1920	2120	2750	1201
1921	2325	3000	1770
1922	3045	3050	2129

III - Total Maintenance Per Mi. of track. \$

	Memphis	Nashville	Knoxville
1913	2220	2900	1215
1914	1418	2050	787
1915	1176	1520	756
1916	1445	1350	754
1917	1604	1660	1091
1918	1890	2220	1166
1920	2440	2700	1728
1920	3220	4500	2394
1921	3080	4250	3356
1922	2600	3580	3787

GENERAL SHEET #34 (Cont'd)

IV - Total Maintenance. #

	Memphis	Nashville	Knoxville.
1913	275,203	243,482	56,526
1914	176,528	200,505	43,107
1915	146,563	152,624	41,384
1916	180,522	135,851	41,277
1917	200,828	163,681	59,735
1918	237,308	221,766	63,871
1919	306,490	377,901	94,621
1920	405,349	464,325	138,104
1921	387,625	442,227	183,867
1922	325,655	380,129	208,385

APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject, carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned does not necessarily endorse or approve any statement made, opinion expressed, or conclusions drawn therein, but approves the thesis only for the purpose for which it is submitted.

Name

Chas. A. Perkins

Title
