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MELBOURNE AND METROPOLITAN TRAMWAYS BOARD.

REPORT OF THE CHAIRMAN

OF THE

MELBOURNE AND METROPOLITAN TRAMWAYS BOARD

UPON HIS

VISIT TO AMERICA, GREAT BRITAIN, AND THE CONTINENT OF EUROPE

IN CONNEXION WITH

ELECTRIC TRAMWAYS.

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MELBOURNE AND METROPOLITAN TRAMWAYS BOARD.

CHAIRMAN'S REPORT UPON HIS VISIT TO AMERICA, GREAT BRITAIN, AND THE CONTINENT OF EUROPE, IN CONNEXION WITH ELECTRIC TRAMWAYS.

To the Members of the Melbourne and Metropolitan Tramways Board.

DEAR SIRS,

In accordance with your desire that I should go abroad in order to investigate the question of Conduit System of Electric Tramways in operation in the United States of America and in Great Britain, and on the Continent of Europe, I left Melbourne on 10th March, 1923, and arrived in San Francisco on the 9th April.

I spent a week in San Francisco and a similar period in Los Angeles, inspecting the tramway systems in these cities and interviewing tramway authorities. As you are aware, San Francisco still possesses a cable tramway system operating along the steeper routes of the city, as well as an extensive system of electric tramways. In this respect it very much resembles Melbourne. In addition, the tramways, both cable and electric, are owned and operated partly by the municipality and partly by a company known as the Market-street Railway Company. The cable systems operate on routes that are too steep for the safe operation of electric tramways. There is no conduit system in San Francisco, all the electric lines being constructed on the overhead system. The cable systems there do not differ materially from the cable system in Melbourne except that some cars are a combination of car and dummy, and instead of flying shunts as here, the cars are reversed by turntables or have two-end operation. The President of the Market-street Railway Company (Colonel Clarke) very kindly placed an officer at my disposal, who took me over the various routes and the tramway repair shops. The type of electric car in use in San Francisco is the ordinary "box" car of the "pay-as-you-enter" type. There are no zone fares, a flat rate of 5 cents being charged to every passenger irrespective of the distance travelled. The electric tramway tracks, generally speaking, were in poor condition and extremely noisy. The quadruple lines in Market-street—a street 120 feet in width—render the crossing of the street a difficult and dangerous proceeding at all times to those who have never experienced a similar set of conditions. The tracks of the Market-street Railway Company were about to undergo a considerable reconstruction. In 1913 the City of San Francisco had a very comprehensive report prepared by Mr. Bion Arnold, with a view to the complete municipalization of the whole of the tramways in the city and effecting improvements. So far, however, nothing has been done to give effect to this report. There is necessarily a want of co-ordination and unnecessary competition between the tramway services in the municipality, particularly in Market-street.

The Los Angeles tramway systems are in advance of those in San Francisco. There are also two rival systems there—the Los Angeles Railway Company and the Pacific Railway Company, both operating street electric cars, the Los Angeles Railway Company being much the larger. The type of car in use is the central entrance one, accommodating 56 passengers. The Pacific Railway Company had just introduced a number of new cars. These were amongst the best I saw in the United States. I also had the opportunity of inspecting the workshops of the Pacific Railway Company at San Pedro, the port of Los Angeles. Their arrangement was excellent, and they were a model of what repair shops ought to be. I was pleased on my return to find that the lay-out which Mr. Strickland had prepared for the repair shops at Preston closely resembled the lay-out of the San Pedro Repair Shops in all essential particulars. I am indebted to Mr. Paul Shoup, President of the Pacific Railway Company, and to Mr. Pontius (President) and Mr. Voight (Vice-President) of the Los Angeles Railway Company, for the opportunity of seeing over their respective systems.

Up to the time of my visit, no motor buses ran on tramway routes in either of the above cities, but there was evidence of their growth on inter-urban routes where traffic was light.

On leaving Los Angeles, I next visited Kansas City. The tramways in this city were in the hands of a Receiver owing to financial difficulties. Both tracks and rolling stock were in a poor condition. The tramways were subject to considerable jitney competition.

From Kansas I proceeded to St. Louis, where I had the pleasure of meeting, amongst other transport people, Mr. W. Sawyer, President of the East St. Louis Street Railways, a friend of Mr. Harold Clapp, Chairman of the Victorian Railways Commissioners. Mr Sawyer had considerable experience of the New York Conduit System, and he was good enough to give me the benefit of his opinion on the relative merits of the conduit and the overhead systems. I was assured by him that the New York conduit tramways were unable to earn, with a 5 cent fare, sufficient revenue to meet the operating expenses and overhead charges, entirely owing to the heavy capital outlay. He strongly recommended against the adoption of a conduit system, not only on account of the very heavy capital cost, but also on the ground of the high operating expenses and greater liability to interruption due to snow, flooding of conduits, short circuits due to the Plow contact getting out of order. He estimated that the capital cost of the conduit tramway was more than double that of the overhead system, with no advantages except the absence of any unsightliness due to overhead wires. The type of car and the fare system in St. Louis were similar to those of San Francisco and Los Angeles.

From St. Louis I proceeded to Chicago, which possesses one of the most extensive electric tramway systems in the United States. In addition, there is an elevated system in that part of Chicago designated the Loop District. Chicago, at present, does not possess any subways or underground systems, nor has it any conduit tramways. With the exception of the Chicago Autobus Company, operating abouty fifty buses, Chicago is dependent for street surface transport on tramways. They give a high schedule speed, and, generally speaking, the system is maintained in a state of great efficiency. One of the difficulties in operation pointed out to me was the large number of dead-ends in the city, which tended towards delay. There was, however, a scheme on foot for the doing away with most of these, and re-routing the cars in such a way that these difficulties will be overcome.

I then proceeded to Detroit and Cleveland. The Detroit tramways are wholly municipal. I found that the authorities there were endeavouring to grapple with the problem of how to relieve the street surface congestion, as the street surface cars were unable to successfully cope with traffic demands. Congestion was accentuated by the number of inter-urban cars which run through the city. A commission has been appointed by the city, under the presidency of Mr. Waldron, to report upon the best methods for dealing with the problem. The Commission has engaged the services of Mr. Daniel Turner, Consulting Engineer to the New York Transit Commission, and one of the leading traffic experts of the United States, to prepare a report on the matter. Since my return I have had the advantage of reading an interim report by Messrs. Mayo, Schramm, S. D. Waldron and D. Turner, members of the Detroit Rapid Transit Commission, in which they recommend the building of certain rapid transit lines together with super-streets for fast motor traffic. A reference to this report will be found in the *Electric Railway Journal* of 29th March, 1924. It had been urged that the complete solution of Detroit's traffic problem would be found in the adoption of motor buses. One proposal was to install a fleet of motor omnibuses each with a seating capacity of 250 passengers. I attach a copy of the Commission's report on this proposal. In this report it is clearly pointed out that for mass transportation along street surfaces, the electric tramcar is the most effective and economic means of transport, but where the volume of traffic is sufficient to warrant it, the best results are to be achieved by co-ordination of a rapid transport system of tramways and motor buses—motor buses being employed as an auxiliary to augment the tramway service, and to operate where the traffic is light, and as feeders to tramways.

I spent a day in Cleveland, where I met Mr. Joseph Stanley, President of the Cleveland Street Railways Company; also Mr. Peter Witt, the Public Commissioner of Cleveland and the inventor of the Peter Witt car. The Cleveland Railways Company operates under a franchise to the City of Cleveland on a system known as a "service at cost," evolved by Judge Taylor of that city. Under this system the assets of the company were determined by valuation, in order to arrive at the physical value thereof as an operating concern. It was then agreed that the company should only charge such a fare as would reimburse the company all outgoings in connexion with the operation of the undertaking, together with 5 per cent. on the amount of the physical value of the property as ascertained by valuation in the manner above mentioned. The Public Commissioner has the power to prescribe the frequency of the service and the number of cars to meet the requirements of the service in accordance with any public demands. The fare charged is 5 cents per passenger journey, but is subject to automatic increase or decrease according as the fare for the time being is in excess of or below what is required to meet the company's outgoings, including the 5 per cent. on capital. On the other hand, if the gross revenue is insufficient to meet all these demands, the fare is automatically increased.

As my main purpose abroad was to inquire into the relative merits of the overhead and the conduit systems of electric tramways, I devoted a good deal of attention to examining the conduit systems of New York and Washington.

New York and Washington are the only two cities in America which have conduit systems. In the Borough of Manhattan (New York proper) the whole of the tramway systems are conduit, there being no overhead wires. They are operated by over 30 different companies. With the high wages costs prevailing and the average distance travelled per passenger journey, it has been found impossible for the tramways to meet their annual obligations with the 5-cent fare. Since 1907, they, or most of them, have been in the hands of the Receiver, and this notwithstanding the volume of traffic is greater than the tramways can handle. In New York I had the pleasure of meeting Mr. Daniel Turner, whose name I have previously mentioned, personally.

He was recommended to me by Mr. Frank Hedley, Vice-President of the Inter-Borough Rapid Transit Company of New York, as being the highest authority I could consult. I had a number of interviews with Mr. Turner, and so greatly was I impressed with his knowledge of street transport that I cabled the Board for permission to obtain his advice upon the Board's general scheme for the development of the tramways of Melbourne, as approved by the Parliamentary Standing Committee on Railways, and particularly as to his views upon the relative merits of the conduit system as compared with the overhead system of electric tramways. Upon receiving the Board's approval, I submitted to Mr. Turner a series of questions, and, after discussing fully with him, I invited him to reply thereto. A copy of questions and his replies to same will be found attached hereto.

It will be observed that Mr. Turner does not favour the conduit system as against the overhead trolley system. He points out that, on account of the expensive construction costs and its relatively high maintenance cost during operation, the system has been rendered obsolete, and that its use in place of an overhead trolley system is not justifiable. Its sole advantage is that of being slightly less unsightly than the overhead trolley system.

On the question of the relative merits of the overhead trolley system of tramways as compared with motor omnibuses, I append to this Report extracts from a report by Mr. John A. Beeler, Consulting Engineer to the New York Transit Commission, which was published in the *Bus Transportation Journal* (New York) of February, 1923. Mr. Beeler's observations are also borne out by the report of Mr. W. H. Mattinson (General Manager of the Manchester Corporation Tramways) to the Tramways Commission of the City of Manchester upon the Comparative Utility of the Motorbus and Tramcar—extracts of which are also appended to this Report.

Mr. Beeler argues that the tramcar operating over rails is not only steadier and smoother running than the bus, but with safety is able to carry more passengers. The bus winding in and out of traffic and operating over pavements is subject to lurches and movements which limit its capacity to one passenger per seat. The ever steady tramcar should carry four standing passengers to each five seated at the maximum load period, when the rush hour demands are greatly in excess of the bus capacity, as in all large cities. This difference in capacity of the bus has much to do with the fact that no important city (in America) is yet served solely by buses. Mr. Beeler estimates that the cost of a motor-bus service in New York to take the place of the street railway services would be approximately 65 per cent. greater than the latter, and that, whilst a bus service should result in a more frequent headway where light travelling exists, it would introduce intolerable congestion where traffic is heavy.

Up to the middle of 1923 there were only about four motor-bus services carried on on a scale of magnitude. In New York there are approximately 300 buses operated by the Fifth-avenue Coach Company at a 10-cent fare as against a 5-cent fare on the street cars. In addition, there was a service running under a municipal franchise along certain municipal routes in Bronx and one or two other suburbs of New York. Chicago had about 50 buses operated by the Chicago Coach Company, which, I understand, is about to be amalgamated with the Fifth-avenue Company of New York. Detroit has 25 or 30 municipal buses carrying approximately 56 passengers each. There were also a small number of similar buses in Philadelphia, operated by the Philadelphia Rapid Transit Company, and also some in St. Louis. The total number of passengers carried by buses in the United States in large cities bears a very small relation to the total transported by street cars. Taking the figures for the whole of the United States, the number of passengers carried on the street cars amounts approximately to 16,000,000,000 per annum, whilst the number transported by buses in large cities would not exceed 200,000,000. There are, of course, a large number of tourists buses and jitneys, amounting in all to perhaps a couple of thousand, but so far they have not been a sensible factor in passenger transport of large cities when compared with street railways.

The general discussions which I had with gentlemen such as Mr. Sproule, President of the Southern Pacific Railways; Mr. Shoup, President of the Pacific Railway Company; Mr. Pontius, Mr. Voight, Mr. Hedley; Mr. Sawyer, of East St. Louis; Mr. Blair, Vice-President of the Chicago Railway Company; Mr. McWhirter, Vice-President of the Third-avenue Company, New York; Mr. Hanna, Vice-President of the Capitol Traction Company of Washington, D.C., all of whom

I have previously referred to, concur in the view that, whilst motor buses have a distinctly useful field in any scheme of passenger transportation in large cities, they cannot displace the tramcar for cheapness or efficiency in moving great masses of people at the period of rush-hour traffic; that their useful field of employment is to augment the services of heavy traffic lines, where the headway of the street cars has become so short as to prevent an increase in the number of the cars on the route at hours of peak load, and the traffic pressure has to be relieved by other means of transport either along the same or some parallel route in the immediate vicinity. The second useful purpose is the use of motor buses on routes where the traffic is not dense enough to justify the laying down of a permanent tramway track. Such buses act as auxiliaries to and feeders for the existing tramway lines until such time as the density of traffic is such that it can be more economically handled by tramcars. In most of the large cities of America street transport is regulated by some form of commission, such as the New York Transit Commission in the City of New York and the Public Utilities Commission of Chicago. Before any motor bus can enter upon street transport services in such cities, it is necessary for the proprietors to obtain a certificate of convenience or necessity permitting them to operate. Were it not for such provisions, the tramway routes through all the large cities in America would have been flooded with motor omnibuses and passenger traffic reduced to a condition of chaos such as prevails in London at the present time.

Proceeding from New York to Great Britain, I investigated the position of conduit electric tramways there. I found that the only existing conduit system was that of the London County Council. It is unquestionably ahead of anything elsewhere in the world as a conduit system. In the early days of its existence many difficulties were met with in operation, but, as the result of the long experience of a highly-trained technical staff, most of the major difficulties connected with the system have been eliminated, and a reliable service has been established. In all the streets where the conduit systems have been established, a combined system of drainage for stormwater and sewerage has been instituted, hence it is easy to drain the conduits. The most frequent causes of interruption on the London County Council tramways are due to defective plows, brought about by injuries caused by bolts dropping off vehicles and wedging themselves in the slot in which the stem of the plow runs. There are also short circuits due to other causes; but, on the whole, I was satisfied that if an efficient drainage system existed in Melbourne which would conduct away stormwater from the tunnels of the conduit, there is, theoretically, no reason why a conduit system would not be fairly successful. The capital cost of installation, however, of a conduit system is at least double that of an overhead system, and the operating expenses considerably greater. In order that I should have exact information as to the reliability or otherwise of the London Conduit System, shortly before leaving London I asked Mr. Bruce, the Traffic Manager of the London County Council Tramways to state his experience of the operation of the Conduit System over a period of years. He was good enough to place his views in writing, a copy of which will be found on page 14 of this report. Bournemouth and Blackpool each formerly possessed a conduit system; in both cases the conduit as been superseded by an overhead trolley system. I attach on page 22 copy of the opinion of Mr. Bulfin, Manager of the Bournemouth operations, on the subject and his experience of the Bournemouth conduit system while it existed.

I spent some days in Paris, going over the Paris system with Mr. Vergniole, Chief Mechanical Engineer. In order that I should get an accurate statement of the relative merits of conduit and overhead systems in that city, I submitted to Mr. Vergniole a number of questions, of which I attach a copy, vide pages 22, 23 and 24, together with his replies thereto.

In conversation, Mr. Verniole assured me that the adoption of a conduit system in Paris was purely on the grounds of æsthetic considerations, but that its cost from an economic point of view is prohibitive even in a city with the dense population of Paris. From an engineering point of view he could not recommend its adoption, under any conditions, as against an overhead system.

The Paris conduit system is a central slot system similar to that of London, but has a different method for detaching the plow when the car reaches a change-over point. In London, at each change-over point, two men are employed, whereas in Paris, and in Brussels which has a side slot system, the detachment of the plow is effected by lifting same out of the slot by means of a hoist operated by a small electric motor. As in Paris, the cost of a conduit system was estimated to be double that of an overhead system, and the operating expenses 25 per cent. greater.

The General Manager of the Brussels Tramways, M. de Lancker, had a great dislike to the conduit system, and would like to have seen it discarded on account of the high cost of operation; but the abandonment of a conduit system has always been opposed by the Government on the ground of street amenities.

From my investigations of the conduit systems above referred to, and my conversations with the gentlemen responsible for their operation, I am convinced that—apart altogether from the troubles arising in operation peculiar to conduit tramways and the higher cost of such operation—the heavy cost of construction as compared with an overhead system and the consequent standing charges render the adoption of a conduit system, either in the whole or in part, impossible in Melbourne.

I also had the privilege of interviews with Lord Ashfield, Chairman of the Associated Companies known as "The London Combine," comprising the "London Tubes," the London General Omnibus Company, and the London United Tramway Companies, and Mr. Frank Pick (one of his associate directors).

I fully discussed our street transport problem with them and submitted our General Scheme for providing for the future street transport of Melbourne to them for their perusal and opinion.

The advice tendered to me by them was that we should convert our cable system to electric traction so as to obtain a unified system, but to proceed with caution in building new tramway routes. They were of opinion that for cross-town services and for new routes not required to handle dense traffic, motor omnibuses would effectively handle the traffic, and, at the same time, effect a saving in capital expenditure with a resultant reduction in overhead charges. At the same time they pointed out that suitably constructed roads were essential for heavy motor traffic.

I also obtained confidentially particulars of costs of operation of their buses and other valuable information.

My experience abroad enables me to fully endorse the views expressed in the Interim Report attached to the Board's Annual Report and Statement of Accounts for the year ended 30th June, 1922, in regard to the impossibility of the adoption of a conduit system for Melbourne.

Although my chief mission was to investigate the problem of conduit systems, I took the opportunity of visiting the largest tramway systems in Great Britain and ascertaining their views upon street passenger transport generally. I attended the Municipal Tramways Association Conference, held at Portsmouth in August of last year, where I met all the leading Tramway Managers, including Mr. Dalrymple, of the Glasgow Tramways, Mr. A. L. C. Fell (General Manager of the London County Council Tramways), Mr. Baker (General Manager of the Birmingham Corporation Tramways), Mr. Goodyer (Croydon Corporation Tramways), Mr. Priestly (General Manager, Liverpool Tramways), Mr. Pilcher (Edinburgh Tramways), Mr. Fearnley (Sheffield Tramways), Mr. J. B. Hamilton (General Manager, Leeds Tramways), Mr. I. Bulfin (Bournemouth Corporation Tramways), and many others, and subsequently visited their respective tramway systems.

One of the subjects for discussion at that Conference was the relative utility of the tramcar, the trolley bus, and the motor omnibus. A paper on the subject was read by Mr. Arthur Baker, of Birmingham, a copy of which I attach. Mr. Baker, in the paper referred to, expressed the following views:—

> "My opinion is, that for dealing with large volumes of traffic, tramways still hold the field, and there are no signs at the present time of any other system being developed which is likely to supersede them.
>
> If I were asked as to how I would employ petrol omnibuses and trolley omnibuses in conjunction with tramways, I would be inclined to suggest, although in every case local conditions would have to be the deciding factor, as follows:—
>
> 1. In anticipation of an extension of an existing tramway, where it was reasonably probable that tramways would be required at some future date, I would use the trolley omnibus. All that would have to be done would be to plant poles and fit up the overhead wires, which could be used afterwards for the tramways.
> 2. I would use the trolley omnibus in substitution for a single line of tramway where the traffics are light or where it was not possible to double the track, particularly when faced with reconstruction. In other words, I would repeat the Nechells experiment, and in this connexion I believe there are several of the smaller provincial undertakings in this country who are faced with entire reconstruction of their tracks who would be well advised to consider the question of abandoning their tramways and to substitute trolley omnibuses therefor.
> 3. On routes in suburban districts where some sort of transport was necessary and where there was no likelihood of trams being required, I would certainly use the petrol bus.
> 4. I would use the petrol bus in running cross-country routes and in connecting up the outer termini of tramways. Motor omnibuses can be made to serve a most useful purpose in linking together the country ends of the tramways. Cross-country services of this kind have proved an unqualified success in Birmingham, and are highly appreciated by the public.

"I think I have shown that there is a field for every kind of passenger transport, and I believe that municipal authorities, at any rate, under the guidance of the responsible officers, can be safely left to utilize the best method of transport for their own particular needs."

"In concluding this short description of the Birmingham experiment, I desire to repeat and emphasize what I have already stated, viz., that for the transport of large masses of people expeditiously and cheaply, the humble tramcar has no competitor, and still holds the field."

The views expressed by Mr. Baker were unanimously endorsed by all the representatives of the municipal tramways systems of Great Britain attending the conference.

To shortly sum up the conclusions I have arrived at as a result of my visit abroad—

CONDUIT AND OVERHEAD TROLLEY SYSTEMS.

(1) However desirable it may be on the ground of street amenities that there should be no overhead trolley wires in the city, it is, judging from the experience of New York, Washington, London, Paris, and Brussels, financially impossible to install a conduit system in Melbourne, even to the smallest extent. I was assured that if the construction of the systems above referred to had to come up for consideration at the present time, no competent tramway engineer would venture to recommend the adoption of a conduit system.

(2) With the conduit system eliminated, the only alternative for electric tramways is the overhead system.

(3) Even in the case of an overhead system the extent of its employment has become restricted owing to the greatly increased price of labour and materials as compared with pre-war conditions. Electric tramways cannot now be built on the lavish scale of pre-war days.

(4) Where the density of traffic would not justify the laying down of tracks, two other forms of transport merit consideration :—

(*a*) Trolley omnibuses.
(*b*) Motor omnibuses.

The former is, in essence, a railless tramcar electrically operated, taking its power from an overhead wire similarly to a tramcar; but as there is no rail for negative return a complete metallic circuit has to be substituted.

It will be seen from Mr. Baker's paper, read at the Portsmouth Conference above referred to, that it occupies a field of usefulness midway between the tramcar and motor omnibus.

The motor omnibus can be made to serve a most useful purpose for operating cross-town routes, connecting up the outer termini of tramways, and developing new routes which at the commencement will not justify the laying of a tramway; or to augment the service upon a tramway route which has reached the saturation point by operating along the same street or along parallel streets in close proximity thereto.

(5) A motor omnibus service cannot take the place of a modern tramway service in a large city, using cars of large capacity at times of peak load. The great obstacle to the more frequent employment of motor omnibuses in Melbourne is the absence of properly-constructed roads adapted to such services—except in the city proper and a few streets in the suburbs. With the advent of better roads in the suburbs the motor bus should be employed instead of the tramcar where no tramways at present exist, until the density of traffic along a given route would exceed 100,000 car miles per mile of route.

It is clear from the traffic returns on many of the Board's lines that under present rates of wages and the various obligations imposed by the Board's Act, such lines are incapable, and will remain so for some years to come, of meeting their share of the cost of operation.

(6) The essential thing for the development of passenger transport for the outer suburbs is the building of suitable arterial roads capable of sustaining heavy motor traffic, to which all users should contribute on an equitable basis.

It is unfair, however, that motor omnibuses operated by the Tramways Board should be under an obligation to contribute both to the construction and maintenance of any roads upon which it may run motor bus services, whilst competitors are free from any corresponding obligation and can compete along the very routes in respect of which the Board has to contribute to construction and maintenance of the roadway.

(7) If the Board is not to be the sole street passenger transport authority, it is imperative that there should be regulations defining routes and fares in order to prevent duplication of services, involving community waste. If two or more bus services are permitted to operate along the same route, there will be continuous efforts to forge ahead of each other in order to secure waiting intending passengers, thus increasing the risk of accidents.

It will also be necessary to see that the routes are so arranged that there will be no unnecessary invasion of the minimum tributary territory necessary to the support of any particular tramway route.

With the exception of London, Perth and Adelaide, and Wellington, New Zealand, there is scarcely a large city anywhere where some provision is not made for regulating traffic competition.

Recently, in London, a Traffic Regulation Act has been passed, and for some years past the provincial cities of Great Britain have had the power to regulate traffic competition, subject to appeal to the Minister of Transport.

I have to acknowledge my indebtedness to the gentlemen I have named, and also to Sir John Timpson, President of the Municipal Tramways Association of Great Britain, Mr. Joseph Beckett, Secretary, and the Members of the Executive of the Association, as well as to many others for their help given and the courtesy shown to me by them at all times, during my visit to Great Britain.

Yours faithfully,

ALEX. CAMERON,

Chairman.

Melbourne,

29th October, 1924.

Extract from the "Electric Railway Journal," 29th *March*, 1924.

DETROIT ANSWERS MOTOR BUS PROPOSAL.

Rapid Transit Commission and Department of Street Railways present a brief to the Common Council of the city in reply to a proposition to substitute buses of a new type carrying 250 passengers for the surface cars and proposed Rapid Transit System.

Recently a petition was presented to the Common Council of the City of Detroit for the substitution of a new type of autobus to supplant the present surface cars operated by the city, and to forestall the construction of a rapid transit system for which plans are now being prepared by the Rapid Transit Commission. The most revolutionary feature of the plan is the use of a vehicle with a capacity of 250 passengers.

A joint answer has been filed with the Common Council, signed jointly by William B. Mayo, Commissioner and General Manager, and Ross Schram, Assistant General Manager, for the Department of Street Railways, and by Sidney D. Waldon, Chairman, and Daniel L. Turner, Consulting Engineer, for the Rapid Transit Commission. This answer, which cites the main argument against the proposition, is particularly interesting to electric railway men since it expresses the opinion of the city's transportation executives regarding transportation methods where all the facilities are owned by the city, or are being planned as municipal project, An abstract of the reply, as addressed to the Common Council, follows:—

The City's Statement.

The petitioner claims, among other things, "that the proposed new type of autobus has been proved to be superior to the street car in every conceivable manner." He then recommends that the city "build and prove the bus," and "effect complete substitution of buses for street cars as quickly as possible." The petitioner further claims that "the bus will provide rapid transit on present streets for an indefinite period," and then states that, "assuming the bus will not provide rapid transit in the present streets, it is still worth while as a substitute for street cars, but more particularly it is still the most valuable rapid transit conveyance because it will do everything that a train will do, and do it better." The petitioner admits that, "Some may say that this is all premature and should not be thought of until the bus is built and proved."

In this latter conclusion, the commissioners and engineers of both the Department of Street Railways and of the Rapid Transit Commission state that they are in entire agreement with the petitioner. Considering only the major issues involved, they may be stated as follows:—

1. Shall the city decide now that its street railway system is obsolete and proceed to adopt the proposed new type of autobus with which to replace it?
2. Shall the city decide now that the proposed new type of autobus will be able to carry such loads of passengers at such speeds through the streets as to make it unnecessary for Detroit further to consider the use of trains upon exclusive rights of way, below or above ground, as a necessary rapid transit requirement?

These two questions seem to sum up the main points contained in the petition, states the reply.

The street car and the present or future motor bus are held to be essentially surface vehicles, each with its proper place in the scheme of surface transportation of great cities. However, neither the street car nor the motor bus operating upon the street surface will meet the requirements of urban rapid transit, but that safety, capacity, economy in operation, and speed will demand the exclusive right of way, underground in the thickly built-up sections of the city and on the surface, with suitable grade separations wherever possible, in the outlying districts, and with six, eight or ten-car train units, as now used in New York City.

At the present time in Detroit the motor bus and the street car are, to a large extent, serving two different purposes and are each aiding the other, even though in some places their routes occupy the same street. The motor bus is a smaller vehicle, giving a seat to every passenger, making fewer stops to take on and discharge a full load, and consequently, giving a faster service between points. For this limited, or special service, the rider pays a special and higher rate of fare.

The street car does not guarantee a seat, but it does stand in the position of giving to Detroit its mass transportation until construction is authorized and completed upon a real rapid transit system. It is, and must continue to be, the backbone of the city's mass transportation until such time as it can be gradually relieved by underground train operation. For the absence of a guaranteed seat the street car gives a ride at a lower rate of fare.

Importance of the Motor Bus Recognized.

Following a sketch of the development of the bus as a factor in urban transportation, which has taken place in the last twenty years, the answer states that the importance of the motor bus as an element of urban transportation upon the surface is being recognized more and more every day, and it is destined to play an increasingly important part in circulating and distributing the population of our cities in the future. But admitting this fact, the conclusion that the motor bus is now ready to supersede all other means of urban transportation is wholly unjustifiable. The motor bus must still pass through many stages of development before any city can afford to consider seriously substituting the motor bus for the street car for its first step in mass transportation.

While it is not important in comparison with the main issue under consideration, the practical engineering and operating side of the proposed new type of 250-passenger motor bus proposal should be mentioned, states the answer. It is suggested that the city, with an experience covering the use of 48 and 60-passenger vehicles, jump to the construction of buses capable of carrying 250 passengers. It is proposed to incorporate into this proposed new type of bus a number of elements not now in regular use in motor bus operation, and with a very limited amount of experience after one is built to launch into manufacturing and operating committments upon an extensive scale.

To jump from a 60-passenger vehicle, steered and controlled by one man, with fare collection attended to by another man, to a 250-passenger vehicle also steered and controlled by one man, and with fares collected by another man, with all of the unsolved problems such a jump presents, would not normally be undertaken by any private company with its own money, and with its own future staked upon the result. The evolution would be gradual. Is it wise to recommend doing with public funds what no one has attempted to do, or would seriously consider doing, with private capital?

The city of Detroit has invested in its street railways approximately $40,000,000. With this system it serve, 93 per cent. of the total revenue passengers at a 6-cent. fares the remaining 7 per cent. being carried by the bus lines and by jitneys at a 10-cent. fare. The service offered compares favorably with that offered in any other city.

It is now proposed that this self-supporting transportation system be discarded as rapidly as possible as obsolete and be replaced with a new type of vehicle yet to be built and proved out at city expense. The writers state that they fear that numerous taxpayers might consider such action imprudent.

They are quite in accord with the idea that there should be more buses as this would avoid the cost of the less important extensions to street railway lines that would otherwise be necessary, pending the construction of a rapid transit system, but they do not advise an increase in buses for the purpose of displacing the surface car system.

STREETS ARE INADEQUATE FOR RAPID TRANSIT SERVICE.

Considering the second half of the proposal, that the motor bus be utilized for rapid transit instead of trains on rails, there are inherent and controlling reasons against it. The city's street system is wholly inadequate for any such use, according to the writers. The existing streets were originally planned for a two or three-story town and for man and horse traffic. On the one hand the automobile has been substituted for the horse, and on the other hand people are being piled up layer upon layer in multi-storied buildings. Already the 23-story building has been reached in Detroit, the 32-story building is in prospect, and the end is not in sight. In other words, in some places, we are super-imposing ten cities on one, and yet the same circulating and distributing street system that was designed to serve a two-story village is expected to continue to serve a 25 or 30-story city.

The capacity of the land is flexible. The sky is the only limit. But the street capacity is inflexible and made so by the very bulk and cost of the enormous structures that impose the greatest traffic burden upon the streets they hem in so tightly.

What is needed is new street space, not an increased use of the existing streets. Only when rapid transit subway or elevated lines are constructed through the developed and congested sections of the city will this new street space be really provided by building under or over the existing street.

Rapid transit presupposes mass transportation at high speed. High speed is impossible on the surface of the street congested with all other kinds of surface traffic. Again, high speed cannot be attained when the transit vehicles are interfered with by cross traffic at every street intersection. High speed in congested streets is impossible with safety. The essential feature of rapid transit lines is that they must be located where they will not be subjected to interferences from any kind of traffic either along the line or at intersections with it. In the outlying and undeveloped sections of the city the streets can be made wide enough to permit a rapid transit line to operate on the surface over an exclusive right-of-way in the centre of the street, with cross streets carried over or under the line, thereby eliminating all surface interferences. But in the developed sections of the city such a thing is not possible because the streets cannot be widened sufficiently. These are the conditions under which subways or elevated lines must be constructed, thereby permitting a high speed to be attained through the congested districts, at least three or four times what is possible on the surface.

The petition so far as it relates to the substitution of the proposed new type of motor bus for the present street car system is considered to be unwise, uneconomical, and contrary to the best interests of the city. As to the claims that the proposed new type of motor bus will provide rapid transit upon the existing streets and make unnecessary real rapid transit on rails upon exclusive rights of way, this is regarded as impracticable and the claims are not borne out by fact. Subway rapid transit will serve the public with the maximum of safety, economy, and speed. The motor bus is still in an evolutionary stage, both mechanically and as a surface transportation medium. It has a service to render as an aid to the street car system, but not as substitute for it.

Copy of Questionnaire submitted to Mr. Daniel Turner and his replies to same.

15th August, 1923.

ALEX. CAMERON, ESQ.,
Chairman of the Melbourne and Metropolitan Tramways Board,
Melbourne, Victoria, Australia.

DEAR SIR,—

This is in answer to your letter of 4th June, 1923, requesting me to give a general answer to certain questions which you submitted.

Melbourne and Metropolitan Tramways Board's General Scheme.

At the outset, I want to say that I have studied with a great deal of interest the papers relating to the Melbourne transit conditions, and particularly the report with respect to—

"*The Proposals of the Melbourne and Metropolitan Tramways Board for a General Scheme for the Future Development of Tramways for the Service of the Metropolis.*"

I am very favorably impressed with this Report. It presents the problem and its solution admirably. Of course, not being familiar with the problem in detail, it is impossible to express an opinion with respect to the merits of the solution in detail. But I am fully in accord with the principles which have been set forth as forming the basis for the recommendations made.

The report deals with the future as well as with the present transit conditions. In other words, quoting, "The Board's aim is to construct a framework upon which systematic extensions can be made to meet further possible needs, without disturbing the proper functioning of existing and projected tramways, or altering the location of any of the main lines."

This is planning comprehensively, as well as for immediate needs, and is essential if the best results in the interest of the community are to be attained. It means that transit facilities can be made to precede the population, not follow the population. The city under such a principle of transit development is enabled to grow and expand in an orderly and in a pre-determined manner. This principle is fundamental. Failure to consider it is chiefly responsible for the transit conditions now prevailing in our largest cities. In most cases transit has been provided in response to the urge of immediate necessity. The thing that had to be done at once controlled. Not much consideration was given to the future. So as each new urge required new facilities, the immediate necessity was provided for independently. There was no comprehensive plan available to be fitted into. Consequently there could be no orderly transit development. It was all piecemeal development. The inevitable result of such a piecemeal transit development has been a conglomeration of transit lines—not a transit system. This is all wrong.

You, on the contrary, as I understand it, are looking ahead and at the start are making a complete picture of the transit requirements as far into the future as you can reasonably visualize the problem and you are proposing to make each new extension of your system, as it is needed, fit into the picture as nearly as may be. This is the only right way to proceed. Permit me to congratulate you on the broadness of your visions.

The questions and the answers to them follow:—

1. *Question.*—Can an overhead trolley system be reasonably considered as offending against the amenities of important thoroughfares, or be in any real sense a disfigurement to same?

Answer.—If the feeder cables are carried underground and modern construction is utilized, an overhead trolley system is not unsightly enough to in any real sense disfigure important thoroughfares, except as any street railway might do so, and consequently such an overhead system cannot reasonably be considered as offending against the amenities of such thoroughfares.

2. *Question.*—Is the popular objection to an overhead system on the score of unsightliness a sufficient reason for the non-employment of the same?

Answer.—The popular objection of unsightliness is more imaginary than real, and therefore is not a sufficient reason for the non-employment of an overhead trolley system.

3. *Question.*—Is a conduit system economically possible in Melbourne, having regard to the scale of fares charged, to the density of population per mile of track as shown by the Board's estimates in connexion with its general scheme?

Answer.—A conduit system may cost to construct nearly four times as much as an overhead system; a conduit system may cost for maintenance during operation over two times as much as an overhead system; therefore, solely because it is slightly less unsightly than an overhead system, which is the only advantage it possesses over an overhead system, a conduit system would not be sound economy. Consequently, if the fares are to remain the same with the population density given, a conduit system, in my opinion, would not be economically possible.

4. *Question.*—Having perused the proposed scheme of tramways development for Melbourne and having heard the Chairman's statement of the relevant facts pertaining to the scheme in regard to the question of drainage of the conduits and the cost of removing and relaying the existing services of other users of the streets (such as gas, water, and telephone mains, sewer manholes, &c.), could the Board be reasonably expected to adopt a conduit system of electric tramways instead of an overhead trolley system?

Answer.—In view of the excessive construction cost, its relatively high maintenance cost during operation, and its sole advantage of being but slightly less unsightly, the conduit system has become obsolete and its use instead of an overhead trolley system is not justifiable.

Therefore, the Board could not reasonably be expected to adopt a conduit system instead of an overhead system.

5. *Question.*—Speaking generally, can you say whether under present, or any conditions, qualified tramway engineers would advise the adoption of a conduit system as against overhead trolleys?

Answer.—I cannot, of course, speak for any one but myself. But the facts are that the conduit mileage is not increasing, but on the contrary, is decreasing in this country; further, that the amount of such conduit construction is relatively so small (much less than 1 per cent. of the total electric railway mileage in the country), and, finally, that our cities are getting larger all the while, in consequence of which esthetic considerations become more and more important. But despite these considerations, there are no more cities building conduit lines. It seems to me these facts speak for themselves. They indicate that qualified tramway engineers have not advised, or are not advising, the adoption of a conduit system as against the overhead trolley.

6. *Question.*—Are motor omnibuses likely in the near future to supersede trolley cars for mass transportation in cities of the size of Melbourne or larger?

Answer.—I do not believe that motor buses are likely in the near future to supersede trolley cars for mass transportation in large cities. But I do believe that motor buses are destined to play a far greater part in urban and inter-urban transportation in the future than they have done in the past, and ultimately they may displace trolley cars.

7. *Question.*—What would be a proper percentage of the capital cost of a motor omnibus which should be set aside annually to provide for depreciation and what do you consider the effective life of a motor omnibus running on suitable roads?

Answer.—Our best experience indicates that with proper inspection and maintenance the life of a motor bus is about six years, requiring about a 16 per cent. depreciation charge.

8 *Question.*—In view of the fact that gasoline at present costs 65 cents per imperial gallon in Melbourne whilst the present cost of electric power is 1.15d. (2.19 cents) per unit and will become reduced in all probability to a figure approximating three farthings (.75d.) (1.43 cents) per unit and having regard to the smaller carrying capacity of motor omnibuses, can the latter compare favorably with tramcars from an economic standpoint?

Answer.—Gasoline now costs here wholesale about 17½ cents. a gallon—but it fluctuates. The price you give (65 cents.) is nearly four times as much. Electric power costs here about 2.0 cents. per kilowatt hour at the car, as compared with approximately 2.19 cents in Melbourne. So your electric power cost is about the same as our cost. These figures mean that while electric power costs nearly the same in Melbourne as here, that gasoline costs nearly four times as much in Melbourne as here. From these figures, therefore, and without further analysis of relative power costs, it is obvious that if motor buses cannot yet operate here as economically as trolley cars, they certainly cannot do so in Melbourne with gasoline costing nearly four times as much as it does here.

9. *Question.*—What is the present finanical position of street surface railways in New York?

Answer.—Transmitted herewith is a printed summary of Reports of the Street Railway Companies operating in the City of New York for the quarter October-December, 1922, and for the calendar year 1922, prepared by the Transit Commission which will give you a complete *résumé* of the financial conditions of the New York street railways.

Conclusions Discussed in Detail.

The reasons for the above conclusions are set forth in greater detail in what follows.

Overhead versus Conduit Systems.

Conduit systems are practically obsolete in the United States. Most of the earlier systems have since been scrapped and overhead systems substituted therefor. No new mileage is being constructed. The exceptions in this country are those in Washington, D.C., and New York, N.Y., and these systems in reality are the result of extensions to lines originally operated by cable and subsequently electrified. In New York they were also due to special legislation affecting Manhattan Island alone. Even this has been removed partially so as to permit the extension of overhead trolley systems into some portions of the Island. These extensions are not great in length but nevertheless they indicate the trend, that is, the cessation of construction of new or additional conduit mileage and the use of the overhead trolley in its place.

The census of the electric railway industry in the United States for the year 1917 (the latest results available) reveals the fact that out of a total of 44,677 miles of track equipped for electric operation 42,491 miles are overhead trolley, 362 miles are underground conduits, and the balance, or 1,824 miles, are third-rail and other forms such as storage battery and gasoline-electric. The third-rail type is used on elevated and subway lines. These last two types are largely experimental and used in locations having only light traffic. Again, as already pointed out, all the underground conduit mileage is in two locations, one-third being in the District of Columbia, the location of Washington, the capital of the United States, and two-thirds in the borough of Manhattan, in the City of New York.

The foregoing shows clearly the small proportion of conduit type track in the United States and the preponderance of the overhead type, the conduit type being only 8 per cent., while the overhead is 95.1 per cent., the balance 4.1 per cent. being principally third-rail and used on elevated structures or subways.

Furthermore, the operation of the conduit type in New York has been abandoned, to some extent due to the inability of the companies to earn sufficient money at a five-cent fare. This is due to the high cost of construction and maintenance.

Cost of Construction.

Two tables are submitted herewith showing the estimated cost of constructon per mile for both the overhead and the conduit type of track at approximately present-day prices.

OVERHEAD TROLLEY.

Cost of Track and Roadway per mile of Single Track in New York City.

Estimated at 1921 prices.

System I.			System II.		
Company.	Miles of Track.	Cost per Mile. (a)	Company.	Miles of Track.	Cost per Mile. (a)
A.	4·89	$42,900 (b)	A.	35·45	$83,657
B.	69·45	71,300	B.	9·63	81,953
C.	52·64	68,800	C.	95·71	89,986
D.	148·02	72,400	D.	24·36	61,177
E.	234·90	72,700			
F.	7·90	62,700			
G.	21·54	40,900 (c)			
H.	2·03	82,800			
I.	2·52	73,000			
Total	544·89	..	Total	165·15	..

Average, $70,300. Average, $83,900.

Weighted average of both systems, $73,463.

NOTES. (a) Cost includes Grading, Ballast, Ties, Rails, Rail Fastenings, Joints, Special Work, Track-Laying, and Surfacing, all-Paving, Roadway Tools, Bridges, Trestles and Culverts, Crossings, Fences, and Signs, Poles and Fixtures, and all underground conduits.

(b) A large proportion of track is without paving. This company owns no underground conduits.

(c) A large proportion of track is without paving. Special work is a smaller proportion of the whole than is usual.

UNDERGROUND CONDUIT.

Cost of Track and Roadway per mile of Single Track in New York City.

Estimated at 1921 prices.

System I.			System II.		
Company.	Miles of Track.	Cost per Mile.	Company.	Miles of Track.	Cost per Mile.
A.	1·5	$248,553	A.	26·24	$315,489
B.	1·6	250,290	B.	6·62	288,569
C.	2·3	268,489	C.	5·28	287,997
D.	12·3	266,763	D.	7·56	323,689
E.	1·8	300,670	E.	13·43	334,331
F.	5·1	296,770	F.	0·95	236,125
G.	5·2	265,225	G.	0·49	202,410
H.	0·7	248,020			
I.	1·7	271,537			
J.	4·0	254,944			
K.	10·3	277,503			
L.	2·9	263,182			
M.	10·3	288,440			
N.	5·0	249,693			
O.	4·0	235,975			
P.	1·6	210,528			
Q.	18·8	250,486			
R.	16·0	253,134			
S.	18·8	291,384			
Total	123·9	..	Total	60·57	..

Average, $267,300. Average, $313,200.

Weighted average of both systems, $282,400.

NOTE.—Cost includes excavation, backfill, ties, rails, rail fastenings and joints, special work, underground construction, track laying and surfacing, paving inside and outside of railway area, ducts in place and paving over ducts.

The figures in the tables refer to the property of thirteen separate companies in New York for the overhead type of construction and 26 companies for the conduit type. While it is true that some of the overhead type is in outlying sections where there was little obstruction to its construction, and while all the conduit type is in the denser part of the City, nevertheless the results are closely indicative of the difference in cost of the two types.

From these tables it is seen that the present-day cost here per mile of track for the overhead trolley may be considered as lying about between $60,000 and $90,000 with a weigthed average cost of about $73,000, while for the conduit type of construction the figures would be about between $250,000 and $330,000, with a weighted average of about $282,000, a difference of about $209,000 per mile. Thus with a given sum of money available for construction, and assuming average costs, nearly four times as much overhead type can be built as conduit. In other words, interest on the investment for a conduit system would be nearly four times that on the investment necessary for the overhead type.

From the conditions in Melbourne as described to me, it is believed the cost difference as between an overhead and conduit system would favour the overhead system to a greater extent than these figures do. Expressed in another way, these figures mean that the cost of every track mile of conduit system constructed at the centre would build one track mile of overhead system at the centre, and more than 3 such miles of extension lines in the outlying or undeveloped sections of the city, because construction would probably be cheaper there. Therefore, to obtain 1 track mile of conduit at the centre would mean sacrificing more than 3 track miles of extensions that might be had to develop the city. There is not sufficient unsightliness in an overhead system to justify paying such an excessively greater cost for a conduit system.

Thus from the standpoint of cost alone it is seen that the overhead type is far superior to the conduit type, but there is another phase to be considered, and that is the cost of maintenance.

Cost of Maintenance.—The cost of maintenance per mile of track for the two types of construction also shows up to the disadvantage of the conduit type. In the table below the maintenance expenses for the year ending 30th June, 1922, have been analyzed for four systems—two overhead and two conduit systems. These are the same systems for which the cost of construction have been given.

COST OF MAINTENANCE OF WAY AND STRUCTURE FOR UNDERGROUND AND OVERHEAD TROLLEYS, PER MILE OF TRACK, FOR THE YEAR ENDING 30TH JUNE, 1922.

	Conduit.		Overhead.	
	System II.	System I.	System I.	System II.
Sup. of way and structure	$1,103·76	$821·16	$340·73	$306·01
Ballast	..	..	120·16	..
Ties	43·40	..	146·03	188·52
Rails	187·42	17·65	250·07	145·15
Rail fastenings and joints	300·49	44·35	184·55	136·53
Special work	747·63	553·01	134·99	9·19
Underground construction	843·47	150·14	..	..
Roadway and track labour	2,239·74	2,321·51	1,000·50	1,047·67
Paving	3,300·51	2,158·28	2,071·35	774·73
Miscellaneous road and track expenses	651·27	231·66	161·28	81·11
Cleaning and sanding track	812·67	838·61	185·14	162·84
Tube cleaning	..	920·78	..	..
Removal of snow, ice, and sand	531·83	508·14	110·43	142·45
Repairs of tunnels (cr.)	..	..	·08	..
Repairs of bridges, trestles, and culverts	..	..	15·04	..
Repairs of crossings, fences, and signs	..	..	2·80	..
Repairs of signals and interlocking system	..	..	66·15	..
Telephone and telegraph repairs	..	28·99	7·98	..
Other miscellaneous way expenses	184·50	..	19·06	25·82
Pole and fixture repairs	·25	..	46·83	155·90
Underground cond. repairs	2·68	93·58	16·49	99
Transmission system repairs	45·79	142·35	88·78	1·45
Distrib. sys. repairs	808·49	1,605·58	278·93	438·34
Miscel. elec. line expenses	..	·82	97·67	..
Power plant (including sub-station buildings)	29·15	14·59	..	4·01
Other buildings and structures	1,228·94	1,020·78	225·29	161·15
Joint way and structure—dr.	5·95	173·90	..	438·45
Other operations—cr.	965·42	106·78	..	..
Joint way and structure—cr.	..	486·21	..	244·29
Maintenance of Way and structure—Total	$11,702·52	$10,142·84	$5,488·17	$3,976·02
Average	$11,326·18		$4,965·91	

Here, again, there is considerable difference between the two. The cost of maintenance for the conduit type is found to be between $11,000 and $12,000 per mile of track while the overhead type varies between $4,900 and $5,500 per mile of track. The averages for the two systems are $4,966 per mile of track for the overhead and $11,326 for the conduit system. That is to say, the cost of maintenance for the conduit type is over twice that for the overhead type (2.2 times).

From what I have been told about conditions in Melbourne with respect to difficulties of drainage, &c., I am of the opinion that the maintenance costs of a conduit system will be greater than here.

Artistic Considerations.—The popular objection to the overhead system exists largely from the standpoint of its supposedly unsightliness. It is more imaginary than real. It is no doubt a survival of the feeling against the earlier types of overhead construction, particularly when the feeders were carried overhead. In the present day practice, with steel poles and underground feeders such objections disappear. This is especially true if the poles are utilized as lighting fixtures for street lighting, a purpose for which they lend themselves quite readily and satisfactorily both from the standpoint of economy and good lighting.

Conclusion.—It appears, therefore, in conclusion that—

(1) If the feeder cables are carried underground and modern construction is utilized, an overhead trolley system is not unsightly enough to in any real sense disfigure important thoroughfares, except as any street railway might do so, consequently, such an overhead system cannot reasonably be considered as offending against the amenities of such thoroughfares.

(2) The popular objection of unsightliness is more imaginary than real, and, therefore, is not a sufficient reason for the non-employment of an overhead trolley system.

(3) A conduit system may cost to construct nearly four times as much as an overhead system ; a conduit system may cost for maintenance during operation over twice as much as an overhead system, therefore, solely because it is slightly less unsightly than an overhead system, which is the only advantage it possesses over an overhead system, a conduit system would not be sound economy.

(4) In view of its excessive construction cost, its relatively high maintenance cost during operation, and its sole advantage of being slightly less unsightly, the conduit system has become obsolete, and its use instead of an overhead trolley system is not justifiable.

DANIEL L. TURNER,
Consulting Engineer.

Copy letter from Mr. J. K. Bruce, Traffic Manager of London County Council Tramways to Mr. Comeron.

LONDON COUNTY COUNCIL TRAMWAYS.

Offices,
Victoria Embankment,
W.C. 2,
26th November, 1923.

Dear Mr. Cameron.

When you called the other day you expressed a desire to have a few notes on the experience of this department in connexion with the operation of tramways on the conduit system.

As a preliminary, it may be well to note that the London County Council operates 316 miles of single track, 244 miles being constructed for the conduit system of traction, and the remaining 72 for the overhead system.

When the conduit system was first inaugurated, and for some time afterwards, considerable difficulties were experienced—some of these difficulties I will refer to in more or less detail later. When officials and men gained the knowledge which only experience can bring, delays to the services were brought within narrow limits. By way of illustrating the efficiency with which tramways on the conduit system can be operated, the most recent weekly return of delays from all causes on the Council's tramways showed that for every delay 50,705 miles were run. The value of such a mileage per delay will be more evident if consideration is given to the extraordinarily dense traffic on the streets on which this Council's cars have to function. The liability of heavy motor vehicles to break down on the tramway tracks adds to the risks of delays to the tramway services—this, of course, is a type of risk which is common to tramway services operated either on the conduit or the overhead systems. About 50 per cent. of the delays to the London tramway services is attributable to causes other than tramway defects.

In this connexion, it may be of interest to know that breakdown lorries with crews of specially trained men are stationed at suitable points ready to deal with obstructions to the service as such occur.

At this point it may be convenient to refer to those causes of delay which are peculiar to tramways operated on the conduit system. The location of these delays is to be found either in (*a*) the conduit, (*b*) the "plough" collector, which is partly within and partly without the conduit, or (*c*) the "plough" carrier which forms part of the undergear of the car.

The Conduit.

Suspended in the conduit on insulators are two conductor T rails—one negative, the other positive. A T rail may become adrift owing to a fracture of an insulator, to the breaking or bending of an insulator stem which connects the insulator with the roof of the conduit, or to wear of the T rail at bolt holes.

The slot in the road above the conduit may become obstructed by closure due to fracture or nut-stripping of the bars which tie back the rails forming the sides of the conduit slot to the lugs of the conduit yokes, or to the running rails. More often obstruction to the movement of the "plough" along the slot is due to some foreign body becoming jammed in the slot itself. Examples of this are bolts dropped from road vehicles and pieces of chain. The liability to delay from causes of this nature is greatest on streets carrying a dense traffic of heavy motor vehicles. If a narrowing of the conduit slot, or an obstruction therein is not observed, a "plough" may become jammed, with resultant damage to some of the undergear of the car—when this occurs the delay must be serious, as the body of the "plough," which is within the conduit, is not readily accessible.

At section boxes, which occur roughly every half-mile, there are short cables connected with the ends of the conductor tees ; there are also "jumper" cables making direct connexion between the short lengths of conductor T rails at junctions and crossings. Faults sometimes develop in connexion with these short cables.

If dirt is allowed to accumulate in the conduit, electrical troubles naturally arise—a "plough" dragged through mud or slush is likely to be burned by arcing. This, however, is a trouble which practically is no longer met with, except in cases of snowstorms in which salt has been used to dissolve the snow in the streets.

One other point in connexion with the conduit—when torrential rains occur, if the outlet from the sewers is not good, water may accumulate in the floor of the conduit, and rise as high as the conductor T rails and so "short" the section so flooded,

The "Plough."

As already stated, the "plough" may become jammed and dropped from its carrier. Its removal, when so jammed, is sometimes a matter of difficulty and delay. The "plough" may become faulty and cause a short circuit, affecting the whole of the cars on the section. The detection of the faulty "plough" is not always easy, and the movement of the car to a hatch, where the "plough" may be extracted from the conduit, is sometimes a matter of some difficulty.

The "Plough" Carrier.

The "plough" head makes contact with bus bars on the carrier. These bus bars and their cables sometimes become faulty, but this type of defect is not serious.

Generally.

With an experienced and capable staff tramways can be operated on the conduit system with great efficiency.

When considering whether a tramway shall be constructed on the conduit system, there is one factor which overshadows all others, and that it to construct a tramway track the cost for the conduit system will not be less than double the cost of construction for the overhead system. Whether the extra cost of the conduit system can be justified will depend in no small measure on the characteristics of the city in which the installation of electric tramways is contemplated.

Yours faithfully,

(Sgd.) J. K. BRUCE,

Traffic Manager.

Alexander Cameron, Esq.,
Hotel Victoria,
Northumberland-avenue,
W.C.

Excerpts from "Bus Transportation," February, 1923.

TROLLEYS FAVOURED FOR SURFACE TRANSPORT IN LARGE CITIES.

By John A. Beeler, Consulting Engineer.

In any consideration of the possibility of supplanting the present street car service in New York City with an equivalent bus service, the principal factors are the following:—(1) Adequacy, (2) first cost, (3) cost of operation, (4) effects on public. It is necessary to consider adequacy on an all-year basis. No one would think of operating open street cars through the winter, and similarly the open-top double-deck type of bus employed on Fifth Avenue cannot be depended on for its full seating capacity in mass transportation throughout the year. Checks at Thirty-third, Forty-second and Fifty-seventh streets of the number of passengers and seats of the Fifth Avenue buses in each direction between 7 a.m. and 7 p.m. taken on 15th December, 1921, show only a small percentage of seats occupied. At Fifty-seventh-street, the maximum load point, during the evening rush hour when the city's transportation systems are taxed to the utmost, only 65 per cent. of the available seats on the outbound buses are occupied. The observations were taken on a fine clear day with an average temperature of 26 deg. F.

To enclose the upper deck of this type of bus would render the vehicle top heavy and increase the liability to accident. It would also reduce the clearance beneath the elevated and other overhead obstructions. The single-deck type of bus, seating approximately thirty passengers, seems best adapted to the general requirements in New York City.

The bus presents certain opportunities for obtaining greater mobility of service than the street car. It can load at the curb, and in blockades or breakdowns can run around the obstruction. It can be short-lined readily at any desired point and entirely re-routed on short notice in emergencies.

In capacity, however, the bus is less elastic than the street car, a factor of great importance in handling rush-hour crowds. Operating over rails in a fixed path, the street car is not only capable of smoother operation but can with safety and economy be built larger. The bus, weaving in and out of traffic and operating over pavements, the best of which have irregularities, is subject to lurching and abrupt movements that should limit its capacity to one passenger per seat. The average car can provide readily for as many as four standing passengers to each five seated during the maximum load period, and there is flexibility in the application of such a standard.

When the rush-hour demands are greatly in excess of the base, as in all large cities, this difference of capacities puts a considerable handicap on the bus, and undoubtedly has much to do with the fact that no important city as yet is served solely by buses. Where they are used in conjunction with other transportation means it is noticeable that the rush demands on the latter must take care of the passengers who cannot be accommodated by the buses.

The surface lines in Manhattan now operate during the base 561 cars, with an average seating capacity of 42, and in the rush periods 1,002 cars. To carry the same number of passengers on the basis of service stated above would require 786 buses in the base and 2,538 during rush hours. To allow for repairs, &c., 15 per cent. should be added, bringing the total buses required up to 2,919. The surface car traffic on all lines in New York City is about two and one-half times that of the Manhattan lines. Applying this factor 7,297 buses would be required to handle the traffic now carried on the surface lines in the city. Based on the above estimate the utlay for the installation of a complete bus system, including garage and shop facilities, will be at the rate of $7,500 per bus, or a total of $54,727,500 = £10,945,500.

The car lines are already in use and the tracks are in the streets. They have a value which is being determined by the commission. To remove them and restore the paving of the streets will cost millions of dollars. While it does not directly affect this estimate, the question remains as to who would bear the cost of such a change. Undoubtedly it will be borne by the public in one form or another.

Looked at in a broad way, the cost of service includes the total expenditure, whether paid directly by the operating company or indirectly by the public. Although the bus system has the smaller installation cost, the major portion of the difference is that the railway must provide and maintain its roadbed, track and paving. With buses the expense for these items is, as a rule, borne by the taxpayers; but it is none the less an important item in the cost of the service and for a true comparison must be included. Another important factor in determining the cost of service is the relative life of plant and equipment. The bus has a life of one-third that of a street car, or even less.

In New York the cost of street car operation is exceptionally high. The adoption of modern and efficient methods of operation should reduce this materially.

The greater capacity of the street car makes each car-mile operated in base-hour service equivalent to 1.4 bus miles, and each rush hour car-mile equivalent to 2.53 bus-miles, making a weighted average of 1.81 bus-miles to each car-mile over the day. One car-mile costing 45.7 cents is, therefore, the equivalent of 1.81 bus-miles costing 75.1 cents. Hence the cost of bus service, not including the indirect costs mentioned above, is approximately 65 per cent. greater than the average cost of street railway service.

Effect on the Public.

A seat per passenger at all times is an attractive feature of bus service except that it sometimes involves waiting. To secure efficient operation it is necessary to fill all the seats during periods of heavy traffic. Consequently at such times there must be a surplus of passengers waiting, reservoir like, along the route to do this.

In other ways the relative merits of the bus and street-car service depend largely on the territory served. In sparsely settled sections the smaller capacity of the bus is no disadvantage and may even result in greater frequency of service. In many localities, especially where car lines as yet do not exist, the bus may be much more economical on account of the smaller investment.

Effect on Street Congestion.

At present the buses on Fifth Avenue represent 15 per cent. of the total number of vehicles in the street. On account of their size and frequency of stop they are responsible for a great deal more than 15 per cent. of the congestion, however. To increase the rate to seven buses per minute would, with the traffic interferences at intersecting streets, cause an intolerable congestion. Indeed, it is highly questionable if they could receive and discharge their passengers and move through the streets.

In referring to Fifth Avenue it is for the purpose of illustration only. Upon it operates America's largest bus line. The double-deck type of bus used there is admirably suited to the unusual traffic demands, which are largely shopping, sight-seeing and fair weather riding.

Fifth Avenue Operation.

The following table is from an article in the *Electric Railway Journal* of 24th July, 1920, written by George A. Green, general manager and engineer of the Fifth Avenue Coach Company.

The data apply to that section of Fifth Avenue below Fifty seventh-street.

Period.	Buses. Per Hour.	Headway—Seconds.
Morning rush ..	193	18
Mid-day	107	33
Evening rush ..	184	20
Sunday	144	26

The above figures indicate that the number of buses operated in the base is increased 80 per cent. to cover the rush-hour requirements.

It is estimated herein that 786 buses will be required in the mid-day and 2,538 in the rush hours. This means that the number in service during the base will have to be increased 223 per cent. if the buses are to accommodate the rush-hour patrons.

SUMMARY.

The analysis of the proposition to supplant street car service throughout the City of New York with buses may be summed up briefly as follows :—

Adequacy.—Bus service to be adequate must provide each passenger with a seat at all times. The type of bus must be such that its full capacity will be suitable for all seasons and in all weather.

First Cost.—Approximately 7,300 buses, with shop and garage facilities, will be required at an estimated cost of $55,000,000.

Cost of Service.—The cost of bus service will be approximately 65 per cent. greater than street railway services.

Effects on the Public.—Bus service should result in more frequent headway where light travel exists, but will introduce intolerable congestion where traffic is heavy. A seat per passenger sounds desirable, but waiting in line is not popular.

CITY OF MANCHESTER.

TRAMWAYS COMMITTEE.

Extracts from the Report of the Tramways Committee of the City of Manchester on the Comparative Utility of the Motor Bus and Tramcar, together with Extracts from the Report of Mr. Henry Mattinson, General Manager of the Manchester Corporation Tramways, upon whose Report the observations of the Tramways Committee are based.

Comparative Utility of the Motor Bus and Tramcar.

At a meeting of the Tramways Committee held on Tuesday, 31st July, 1923, the accompanying report of the General Manager on the above subject was considered, and the Committee submit the following observations :—

The Tramways Committee's Policy.

A comprehensive consideration of the various acts and deductions outlined in the report leads to the conclusion that the Committee are following a sound, logical, and far-seeing policy in continuing to develop the tramway system to its utmost—they have given due regard to congestion in the central area and, without unduly penalising the passenger who wishes to travel through such area, have, by their system of "terminals," reduced the number of cars within such area to a minimum capable of reasonably conveying the public.

The recent trials of one-man operated motor buses having proved successful, has impelled the Committee to order five more such vehicles, and no doubt, from time to time, the fleet will be increased as circumstances demand.

In conclusion, it might be mentioned that the Committee are prepared to adopt any means at once ecomonical, expeditious, comfortable, and safe, whatever it may be, for the passenger transportation of the City; their adherence to the tramway for the public conveyance of industrial communities arises not because it is a tramway, but from an assured knowledge that at the present time no other instrument is available that can supersede it on its essential merits.

This conclusion is universal, as in no country has the tramcar, dealing with an adequate traffic, been superseded by any other form of vehicle.

The following resolution was adopted, viz. :—

That the report of the General Manager, now submitted, be approved, and that a copy thereof be sent to each member of the Council.

That, having carefully considered the report, the Committee are satisfied that the policy they have hitherto pursued is fully vindicated, viz. :—

To develop, to the fullest extent, the tramway system of the city and surrounding districts.

To utilize, as far as practicable, the motor bus as a "feeder" to such tramways.

The motor bus cannot be considered either as a practical or financial substitute for the tramcar for the passenger transportation of the city and districts nor for the central area only.

JAMES BOWES,
Chairman.

31st July, 1923.

MANCHESTER CORPORATION TRAMWAYS.

Report of Mr. Mattinson on the Comparative Utility of the Motor Bus and Tramcar.

The subject is herein dealt with on general principles only. The application of these principles to specific cases may call for considerable modification, as local circumstances play such an important part in all traffic operations.

Advantages and Disadvantages of the two Vehicles.

Before treating the subject in detail, a few general comparisons are submitted to indicate the fundamental attributes each type of vehicle possesses, which are to be borne in mind in considering the adaptability of the particular vehicle or specific purposes.

Seating Capacity.—The largest motor bus at present seats 26 passengers inside and 28 outside—total, 54 seated. With six standing the full capacity is 60 passengers.

The largest tramcar seats 80, all under cover. With twelve standing the full capacity is 92 passengers.

Covered Accommodation.—The modern tramcar carries all its passengers under cover, a development arising from our climate necessitating such cover over the major portion of the year. Many efforts have been made to design a covered-top bus, and it is doubtful if ever a satisfactory safe vehicle can be evolved for use in urban districts, as, having to operate on cambered roadways, its liability to overturn will be ever present, and the cant due to such camber renders it liable to strike lamp posts and other erections on the footpath edge.

Speed.—The motor bus has a slight advantage in busy streets by reason of its ability to deviate its course around an obstruction, but the tramcar has the highest "average" speed over a reasonably long route, and a much higher rate of acceleration.

Reliability.—Whilst the mechanical reliability of the motor bus has considerably improved, it cannot be compared with the tramcar, and, by the very nature of its construction, never can approach it for reliability.

Utility in Bad Weather.—In thick fog, motor bus services have to be entirely suspended, but the tramcar can proceed, as its position in the road is definite and known to all, and its location is evidenced by its gong.

Safety.—There is no form of transport that operates with such a low percentage of accidents, both to the passengers and pedestrians, as the tramcar, the only operation depending on the human element being speed, and not direction.

The braking efficiency of the tramcar is the highest of all vehicles and, moreover, can be applied by the conductor in case of failure by the driver.

The sudden application of brakes on the other motor vehicles renders them liable to skid laterally, which cannot occur with a tramcar. Tramcars are fitted with lifeguards, which have proved remarkably efficient, but buses cannot be so fitted.

Mobility.—The motor bus has considerably more flexibility than the tramcar. It can move around other vehicles, or even change its route in the event of an obstruction.

In practice, however, the value of this undoubted advantage does not often arise, as the frequency of such interruptions is almost negligible in percentage of journeys effected.

Comfort.—The motor bus is to many people a more "pleasant" vehicle to ride in than a tramcar, but it is not nearly so steady, and reading therein is difficult. For long rides for business purposes the tramcar is undoubtedly the more comfortable. Owing to its limited area inside, the motor bus cannot be so adequately ventilated as a tramcar; when ventilated it is draughty, and if not, it is stuffy and not without evidence of the engine and oil fumes.

Loading.—A very great feature of the motor bus is its ability to draw up to the kerb to discharge and load its passengers, which cannot be done by the tramcar except at prepared refuges. A tramcar, however, by reason of its larger platform, can load and unload much quicker than a bus.

Cost.—Whilst the cost per seat in each vehicle is nearly the same, only about half the seats of the motor bus are covered; consequently, having also smaller seating capacity per vehicle, three to four times as many buses, with garage accommodation, &c., would be necessary satisfactorily to perform the same duty as the tramcar.

"*Peak*" *Loads.*—No bus system attempts to deal adequately with the "peak" load of an industrial community as the number of vehicles, staff, &c., that would be necessary and the standing charges involved, would render it financially impossible. It is the fact that the fixed standing charges are lowered by increased traffic that enables a tramway to deal with "peak" loads on an economical basis.

Congestion.—Seeing that at least three times as many motor buses as tramcars are required to carry the same number of passengers under cover, it must be admitted that thrice the number of buses on the streets than the tramcars would cause more congestion in the central area, even though the tramcars are somewhat longer.

It has been contended that the fixed direction of a tramcar adds to congestion owing to its inability to divert its route around another vehicle. This is debatable, and experienced opinion is agreed that the certainty of the position of a tramcar enables all other vehicles to pass and be passed with such confidence that it more than compensates for other limitations.

Capital Outlay.—The motor bus bears less capital outlay per vehicle, and it has no outlay for permanent way, &c.; but the number of vehicles necessary to carry the same passengers as tramcars would more than balance this in any busy community. The ability to bear the fixed standing charges on the track, &c., is determined by the service operating thereon.

Operating Costs.—Broadly speaking, the operating costs per vehicle-mile is the same for buses as tramcars—staff, power, and maintenance being about the same per vehicle, but the tramcar performs double the duty, and thus not only operates at half the cost of the bus but entails fewer units to perform the same work.

Mechanical First Principles.—The motor bus is an independent power unit with low efficiency, operating with rubber tyres on a variable surface of high frictional resistance.

The tramcar is driven from a central power source of maximum efficiency, and operates by a steel wheel on a steel (rail) surface with a minimum frictional resistance.

Roadway.—The motor bus has not to construct or maintain its own roadway, but the cost of wear and tear due to buses has to be defrayed by the community out of the local rates, subject to the small proportion of the amount paid in respect of excise licences on the buses returnable to the Corporation by the Road Board.

The tramway has to construct its own road (the rail) and maintain a large portion of road surface which is for general use, the rates being thereby relieved of the cost of such work.

Public Funds.—A tramway has to contribute heavy local rates, construct and maintain large areas of highways, share the cost of street widenings, and, in the event of obtaining electric energy from a public undertaking, reduces the general charges of such undertaking — all benefits to the ratepayers that are not realizable from bus undertakings.

Trackless Trolley Buses.

This vehicle may be considered occupying a stage between the independent motor bus and the tramcar, and has, naturally, some of the merits and defects of each. It has not the full degree of flexibility of the motor bus, as it cannot vary its route, but it can deviate around an obstruction, and one vehicle out of order does not interfere with the rest of the service. They are in operation in various towns, viz.:— Leeds, Bradford, Birmingham, amongst others, and operate in their respective localities with satisfaction, the latest and most modern type being in Birmingham.

Some towns have introduced them to avoid reconstruction of their tramlines, not having a service large enough to pay the heavy charges that would arise in view of present-day cost and having the electrical equipment already erected; others use them on routes where the density of the service is sufficient to carry the standing charges on the electrical equipment, but insufficient to carry those on track construction. Local circumstances are the factors deciding the adoption, but the limitation of route is a big objection when the motor bus is already in service elsewhere on the same system.

Given sufficient traffic it operates more cheaply than the independent motor bus, is probably more reliable, but is not so economical as a tramcar when the density of traffic justifies the latter.

Spheres of Operation of Motor Bus.

Motor buses may be employed as follows:—

- As "feeders," to connect remote districts to tramway routes.
- As supplementary to tramcars to assist where a route is "saturated."
- As total substitutes to perform the entire passenger-carrying duties.
- As partial substitutes to deal with the traffic of limited areas.

As "Feeders" to Tramways.—As "feeders," the bus holds an undisputed field where there is a light demand; the capital outlay being a minimum. The frequency of the service can be limited to the needs of the district without involving any fixed standing charges per bus mile on an infrequent service. For such service no comparison with the tramcar is necessary.

As Supplementary to Tramways.—As supplementary to tramways, buses have been used in a few instances, and now operate as such in London, although really as competitors. No doubt, when a tramway route is "saturated," they would assist in transporting the excess passengers, provided they did not cause such added congestion along the route as further to restrict the progress of the tramcars, and so reduce their speed efficiency.

Economically, in such an instance, they could not be operated at the same fares as the tramway, as will be shown later, and, in such circumstances, a comparison of "relative" value does not arise.

The question, therefore, may be limited to the consideration of the use of the motor bus in the two last-mentioned cases only, viz.:—

In total substitution for tramcars;
In partial substitution for tramcars in the central area.

Total Substitution.—To deal with the volume of our traffic at the time of "peak" load requires 537 bogie cars in service, with a seating accommodation of 42,900; allowing a reserve of, say, 10 per cent., it requires 590 cars, with a total seating accommodation of 47,000.

To provide the same *seating* accommodation would require 870 buses, but, as more than half the seats would be uncovered (there being at the present time no satisfactory covered-top buses), it would require at least 50 per cent. more, or a total of 1,300 buses, to give even reasonable satisfaction to the public, and still leave 25 per cent. of the passengers to travel in the open.

Capital Cost.

Our present capital outlay is as follows:—

	£
Tramcars	879,402
Permanent Way and Equipment ..	964,653
Car Sheds, &c.	655,811
Other expenditure	406,154
	£2,906,020

The outlay on motor buses would be approximately:—

	£	£
Motor buses—1,300 at £1,000		1,300,000
Alterations of existing Car Sheds into Garages	100,000	
Provision of New Garages ..	500,000	
		600,000
		£1,900,000

From this it will be seen that to substitute motor buses for tramcars in their entirety would involve a capital outlay of £1,900,000, which would be *additional* to the existing capital outlay, because the cost of removal of the permanent way and electrical equipment and reinstatement would balance any return on realization of the same, and the realizable value of the tramcars as vehicles would be negligible.

The debt incurred in respect of our capital outlay on the tramways is not yet liquidated, and we have, in addition, obligations relating to the tramways in outer districts. These liabilities will continue for about 40 years, but assuming an equated period of 20 years, the charges for interest and sinking fund and rent of tramways would average about £155,000 per annum.

These charges would have to be borne by the bus undertaking, and would involve a cost per bus mile of 1.034 pence. In addition, the cost per bus mile of the new capital outlay for the bus undertaking would be 1.474 pence, making a total charge of 2.508 pence per bus mile on capital account.

Abolition of track would mean a loss to the city of a rateable hereditament on which rates to the value of £52,000 per annum are paid, and, in addition, the maintenance of that portion of the roads, now provided and maintained by the Tramways Department, would cost the ratepayers at least £10,000 per annum, making a total of £62,000 per annum, which is equivalent to a rate of nearly 2½d. in the £.

Operation Costs.

The cost of operation during the last financial year for the two types of vehicles works out as follows per vehicle mile. The figures for the motor buses are adjusted as regards standing charges, and also include certain expenses of the undertaking not now charged to the existing services:—

	Tramcar. Pence.	Motor Bus. Pence.
Traffic Expenses ..	8·065	6·996
General Expenses	2·417	1·731
Repairs and Maintenance.. ..	2·983	3·804
Power Expenses..	2·165	3·015
Total Working Expenses ..	15·630	15·546
Provision for Renewals	2·365	1·088
Capital Charges	2·896	1·474
	20·891	18·108
Capital Charges due to abolition of Tramways ..		1·034
		19·142

The car miles operated last year totalled 20,289,399, and the equivalent motor-bus miles would amount to 35,981,500. At the above cost per vehicle mile the total cost of operating the two types of vehicle would amount to:—

	Cost per annum.	Per vehicle mile. Pence.
Tramcars	£1,766,108	20.891
Motor Buses	2,869,824	19.142
Additional cost of Buses	1,103,716	

In order to meet this additional cost, the fares on the motor buses would have to be fixed to give a stage of about .94 mile for one penny, as against the present stages on the tramways of 1½ mile for one penny. *In other words, the present average fare per mile would have to be raised from .66d. to 1.06 pence, an increase of 61 per cent.*

As Partial Substitutes.—The manner in which the bus might be employed as a partial substitute for the tramcar is that of performing the traffic services of a congested central area, in which it was considered the tramcar an objectionable vehicle.

The only example of this principle in this country is that of London, and the factors that exist there require careful analysis to see if they are applicable to other communities. They may be summarized as follows :—

For generations the only public street conveyance within the tramway-excluded area has been the buses —horse or motor—and the population has become habituated to them.

The central area is extensive, being some 4 miles E. to W. and 3½ miles N. to S., and, being devoid of other methods of surface transit, the public, of necessity, use the bus.

It is not an industrial area, and has not the same "Peak" load characteristic that industrial communities have.

The area covered is the most superbly paved area in the world, being entirely smooth pavement.

No area in the world has the same high average of movement of the population during the whole day—it is a to-and-fro movement involving innumerable short journeys, and conveys a public of such a social status as conduces to frequent journeying.

The density of ordinary vehicular traffic is the highest in the world.

The rush-hour service is provided by the underground railways, which also act as "feeders" to the motor buses at innumerable points within the area, and vice versa.

The area is also "fed" at all points of its boundaries by tramway-conveyed passengers, in addition to the normal movements within the area.

Only the last of the above-mentioned factors would exist in any other city of this country. Whilst the bus-riding habit of London is a very important factor, the principal difference would appear to arise from the size of the area from which the tramways is excluded. This affords a journey distance sufficient to induce travel or justify a change of vehicle, but if such area were reduced to one of, say, a ½ mile radius, a very different condition would arise. The change of vehicle would be irksome, the delay serious in view of the short distance remaining to be performed, and the cost prohibitive, as a less charge than one penny for these journeys is scarcely to be considered, and the short remaining distance to travel would not justify it.

The advocates of abolition of tramcars are apt to view the thoroughfares void of tramcars, but do not visualize their necessary substitutes, i.e., *three times as many buses as tramcars.*

General Observations.

The fundamental basis upon which any form of public transport must stand is the financial, and it is mainly on the consideration of the various systems on this basis that conclusions must finally be determined.

The factor most seriously affecting this view is the density of the traffic to be dealt with, and the ability of any system to bear a heavy capital outlay is purely dependent on this.

An important factor also exists in whether the consideration involves a new undertaking, or of whether it is an extension of an existing undertaking, as in the latter case many charges may be omitted in respect of provisions already made that need not be further increased.

With the motor bus the capital outlay and other expenses may be taken as directly proportional to the number of vehicles employed, irrespective of whether such number be large or small.

The motor bus operation depends mainly on the individual vehicle, and, being independent of the number, the traffic frequency, within limits, has no bearing on the fares, which must remain on present-day costs at about .75 mile per 1d. if employed as "feeders," when the passengers per bus mile will be relatively low.

With the trackless trolley bus, the fixed capital outlay on the electrical equipment, &c., is dependent only on the length of route equipped, the other capital outlay being proportionate to the number of vehicles. The charges in respect to the equipment capital vary inversely to the number of vehicles, i.e., it becomes smaller per vehicle mile as the number of vehicles operated increases.

We have no experience of our own for forming a basis of costs for trackless trolley vehicles, but assuming a charge of 1 mile for 1d., a traffic density of approximately six vehicles per hour (or a ten-minute service), sixteen hours per day, and averaging seventeen passengers per vehicle mile, would enable it to bear its fixed and other capital charges.

As the trackless trolley bus represents a stage in the normal development of a passenger transport route, it becomes a matter of serious consideration whether the period during which it is likely to operate will justify its introduction. The vehicle is not so adaptable for other purposes as a motor bus, and it may be financially sounder to continue to operate the motor bus longer than its economic point, or to instal the tramway earlier than the purely economic stage.

With the tramway, the fixed capital outlay is at least five times as high as in the case of the trackless trolley vehicle, that of the vehicles is similarly directly proportioned to their number, and the charges for fixed capital vary inversely as the vehicle mileage operated, as in the case of trackless trolley buses.

With the tramcar at our present fare of 1½ mile for 1d., for eighteen hours per day, and an average of 32 passengers per car mile, a service of eight cars per hour (7½ minutes) is an economic proposition, but at a higher fare it can operate economically with a much less frequency.

It follows, therefore, that on purely economic grounds, there is a point where the density of the traffic is such as can carry the fixed standing charges, but the ascertainment of this point is complicated by the different traffic value of the vehicles, the variation in average load density, the fares, and not least, the local conditions.

The point where each vehicle becomes the economic instrument cannot be defined in general terms, as with growth of services, longer hours of operation, larger units of conveyance, and lower fares, all operating together, the point where each respective system becomes the economic instrument is modified, giving really an overlapping period indeterminate in duration, except by reference to a precise route.

There does arise a stage where the tramway attains its limit of capacity, such stage being affected by many factors, such as density of other vehicular traffic, frequency of branch roads and crossings, width of roadway, number of tramway junctions, &c.

To add more cars to a route above such stage results in so reducing the average speed over the whole route as actually to convey fewer passengers.

The stage can only be ascertained by actual experience on each separate route, and it may be accepted that on our system, Oxford-road and London-road have practically approached such stage to-day.

Summary.

To summarize the various aspects of the comparative utility of the three forms of public conveyance now available for adoption—and without reference to any particular locality where the conditions may considerably modify any first principles,—it may be taken that—

(*a*) The motor bus is the best and most economic vehicle for any service not requiring a greater frequency than four vehicles per hour, operating on the basis of fares of three-quarters of a mile for 1d.

Above such service it may be fairly assumed that the hours of operation and the average number of passengers per bus mile will increase, and a demand for a lower fare will arise, in which case—

(*b*) The trackless trolley bus is the most economical for services from four to six vehicles per hour, carrying seventeen passengers per mile at a fare of 1d. per mile, and operating sixteen hours per day, conditionally on the period during which it is likely to operate justifying its introduction.

(*c*) The tramcar is undoubtedly the most generally satisfactory vehicle for services of six or more cars per hour, and when it can operate for eighteen hours per day, carrying an average load of 25 passengers per mile and at fares based on 1 mile for 1d., the statutory fare on tramways.

To extend our tramways, and give a flat rate of $1\frac{1}{2}$ mile for 1d., would, however, require a service of eight cars per hour and a load density of 32 passengers per car mile to be an economic proposition.

(*d*) In the event of "saturation" of a tramway route, and the impossibility of providing a relief route, the motor bus may assist up to a point where it does not, by increasing the other vehicular traffic, act to the detriment of the progress of the tramcar.

(*e*) The exclusion of the tramcar from a central area is not practical nor economical until such area is large enough to justify a separate journey by another vehicle.

Motor Bus Competition.

It will not be out of place to refer to the competition permitted in certain towns when motor buses are operated by private individuals in competition with existing tramways.

So long as the tramway performs its duty and carries the public expeditiously and economically, such competition is unfair, and will eventually recoil on the community encouraging it.

The tramway is constructed by the authority of Parliament, and carries with it liabilities and obligations not imposed on buses, which renders the competition most unfair.

It has to perform an all-day service irrespective of whether it is a profitable service or not, and its ability to do so is entirely dependent on its being able to earn during its rush periods, when the number of passengers per vehicle is high, sufficient profit to carry on during the slack periods, when the actual operation is often performed at a loss.

The motor bus of private enterprise will not long continue such duty, and will be found only to operate when the density of traffic enables a profitable load to be carried.

If the tramway is to have its rush traffic reduced by an auxiliary and not an honestly competitive vehicle, then the fares must of necessity be raised or the services during slack periods reduced, to the obvious disadvantage of the community at large.

HENRY MATTINSON,
A.M. Inst. C.E., M. Inst. M. and Cy. E.,
M. Inst. T.,
General Manager.

Tramways Offices,
55, Piccadilly,
Manchester,
July, 1923.

Copy letter from Mr. J H. Hanna, Vice-President, Capitol Traction Co., Washington, U.S.A., to Mr. Cameron.

The Capitol Traction Company,
General Offices, 36th and M Streets,
Washington, D.C.
31st May, 1923.

MR. ALEXANDER CAMERON, Chairman,
Melbourne Tramways Company,
Melbourne, Australia.

My dear Mr. Cameron,

I am pleased to reply to the various questions submitted with your letter of 21st May—concerning which we had a conference about that time—giving you the best information available.

Question No. 1.—The two companies combined in Washington have 112.68 miles, single track, of conduit system. As all of this line is double track the route mileage is somewhat less than one-half the single track mileage after allowing for barn tracks, sidings, &c.

Question No. 2.—I have no actual figures as to the cost of the conduit construction used in Washington at present day prices. This cost varies largely with the amount of special work, such as crossings, &c. At the present market, straight track construction, exclusive of special work, and exclusive of any expense for removing underground obstructions, will run about 25.00 per foot, using our standard 122-lb. rail. A double track branch-off costs, installed complete, about $25,000 and a right angle double crossing about $18,000. These figures are seven or eight times higher than for similar surface track construction. I should say that on the average construction to-day, exclusive of underground obstruction, would be about $150,000 per mile of single track.

Question No. 3.—The cost of removing underground obstructions necessary for building a conduit system varies greatly, depending whether the track to be built is in an improved section or in an outlying district. I have before me the figures for eleven different units of new track construction, all built before the war. The cost of removing underground obstructions varies from $160.00 per mile to $19,470 per mile; the average for the eleven jobs is $5,544. The present day cost would be approximately double this amount.

Question No. 4.—The operation of a conduit system is entirely dependent on proper drainage facilities. Washington is very well taken care of in this respect, having an adequate number of storm sewers. We have not been compelled to build separate drains for our conduits except the connexions between the conduits and sewers. These connexions are usually 100 feet, or less, in length, but as they are always made to sewer manholes, sometimes their length is greater. The size of our sewer connexions depends, principally, on the topographical conditions and the size of the sewer to which the connexion is made. It is our practice to put in as large a connexion (up to 15 inches) as the sewer authorities will permit. These connexions are placed, ordinarily, about 500 or 600 feet apart, being located at each low spot in the grade and at each switch.

Questions 5, 7, *and* 9.—Interruptions to traffic are unquestionably more frequent on a conduit line than on an overhead trolley line. The electric current is brought to the car through a device which we call a plough; this plough has a steel shank $\frac{5}{8}$ of an inch thick through which run insulated conductors. It is impossible to prevent a considerable amount of trouble with the plough, particularly at switches and other special track work where it has to be guided by the narrow slot. This is especially true during snowy or sleety weather. Our delay sheet indicates that from 30 to 50 per cent. of our delays are entirely attributable to the conduit system and would not occur with an overhead system. The principal delays due to this system are:—

Failure of Plough.—Grounded ploughs, burned fuses, broken springs, broken shoes and damaged leads. Failures of this character necessitate pushing in the disabled car and changing the plough. Special slot hatches are provided at different points in the system and a number of ploughs kept at these points so that the distance a disabled car must be pushed varies according to the locality where the failure occurs.

Pulled Ploughs.—Obstructions in conduit—misplaced slot tongues—particularly at switches or other special track work, occasionally pull ploughs from their hangers causing delays of from 15 to 30 minutes. In instances of this kind the plough hangers may be damaged and it is usually necessary to push the car to the nearest barn. Pulled ploughs almost always require the assistance of an emergency waggon in order to get the plough out of the slot. Delays of this character are comparatively rare under ordinary weather conditions, but during snow and sleet storms they occur frequently, as it is very difficult to maintain switches in proper working condition during heavy snows.

Conductor Bar Dropped.—In the conduit system the conductors are two steel T bars supported from the slot rail at intervals of about 15 feet by insulators. Occasionally, through the failure of an insulator or the clip which connects the insulator with the conductor bar, one end of the bar may be dropped from its support to the bottom of the conduit. This, invariably, will break the shoes or springs off from any plough which attempts to cross it and as the fallen bar cannot be seen from the street it is not unusual that a number of cars will pass over such point and consequently become disabled before the difficulty is discovered. Cases of this kind, while rare, cause serious delays.

Cars on Cut-out.—It is necessary to have openings in the conductor bars at all switches and crossings; cars must coast over these openings. It is a comparatively frequent occurrence for cars to stop with the plough opposite such openings in which case they must, of course, be pushed off by another car. Such delays are usually very short in duration, but are rather frequent.

Current Interruptions due to Short Circuits.—Grounds or short circuits of conductor bar may be caused by wire, metal hoops or other conductors getting into the conduit or by flooded conduits on account of heavy rains and insufficient drainage.

Short circuits due to the first cause are rather infrequent; those due to water depend upon weather conditions and adequate drainage. We frequently have here in Washington during the summer months, rainfalls amounting to one inch, or more, an hour. A storm of this sort is almost sure to cause flooding of the conduit at one or more points in the city, causing a short circuit and interruptions to traffic until the sewers carry the water off. Sometimes such trouble lasts two or three hours, but it does not happen often. There have been occasional instances where heavy rains have washed a sufficient amount of gravel and sand into the conduit to completely stop it up, in which event it is necessary, of course, to remove all foreign matter from the conduit before service can be resumed.

Questions 6, 8 *and* 10.—The principal reason for the increase in the operating cost in the conduit system, as compared to the overhead trolley system, is the added cost of the conduit system. I believe I can fairly say that the maintenance costs on track would be proportional to the first cost. The replacement, particularly of special track work, is quite expensive. The total cost of Maintenance of Way and Structures for this Company per mile of track for the year 1922 was $4,940. In the cities of Cincinnati, Cleveland and Baltimore, where the overhead trolley system is in use, the average cost of maintenance per mile of track was $3,000. The expenditures for equipment maintenance would be the same for both systems except for the repairs and up-keep of ploughs. This expense, last year, on our system amounted to .12 cent per car mile. Our total equipment maintenance figures were about 3.25 cents per car mile in 1922. The only other expense incident to the conduit system which occurs to me is the cost of cleaning the conduit which must be done once or twice each year. During 1922 this item amounted to $174.50 per mile of track track. There is also the cost of pitmen, changing from the plough to the trolley system. There are ten such pits in Washington; each requires two or three men. These men are paid $4.45 per day of nine hours.

Questions 11 *and* 12.—The only advantage whatever that the conduit system has over the overhead trolley is the appearance of the city streets. As you know, this system is in use in only two American cities—Washington and New York—and I seriously doubt if its use would be insisted upon in these places if conditions required the building of an entire new system, at the present prices. The Government of the District of Columbia, in which Washington is located, is in the hands of the Congress of the United States, and the city is generally looked upon as something of a show place—a city in which the entire country takes a great pride. For this reason I believe the decision to eliminate trolley wires here was a wise one. I would not care to be an advocate of overhead trolley wires in this city, however. I believe the people who benefit by the added beauty should be brought to understand that this aesthetic advantage is enjoyed at a very considerable expense and that this expense must be considered by them in connexion with the question of car fare. A conduit electric railway system would be entirely unthinkable in any city not equipped with a thorough drainage and sewerage system, as the expense of building a separate, complete sewer system to take care of the water in the conduits would add from 50 to 100 per cent. to the cost of the conduit system. Again, I do not believe that a conduit system should be attempted in any locality where the snow fall is heavy, as a regular thing; its operation in times of snow is extremely difficult and expensive and always accompanied by more interruptions to traffic than would occur with the use of an overhead trolley system.

Questions 13 *and* 14.—I do not believe that motor buses can entirely supersede electric cars for mass transportation, although it is probable that many electric lines now in operation would not be built to-day with the present development of motor bus service. The questions as to relative advantages of the various types of transportation on city streets largely depend upon the density of traffic. This matter has been quite thoroughly covered by several investigators in this country. I am enclosing an abstract of a report made by Mr. John A. Beeler, a very well-known and competent consulting engineer in transportation matters. I have in mind several similar publications which I shall locate and forward to you.

Question 15.—I believe every phase of the situation has been covered in previous paragraphs. I might add, in a general way, that the only advantage of the conduit system is its better appearance on the streets. If the people who must support the transportation system by their patronage desire to pay the additional expense necessary for the aesthetic advantages, and the density of traffic is sufficient to warrant it, there is no reason why a conduit system could not be successfully installed and operated, provided, as stated heretofore, a suitable drainage system is available and the winter weather conditions are not very severe.

I enclose, as requested, some charts showing the distribution of traffic on our system through the twenty-four hours of a normal day.

Be assured that I shall gladly furnish any additional information which may be of use to you.

With best regards, I am,

Sincerely yours,

(Sgd.) J. H. HANNA,

Vice-President.

Note.—The questions referred to above are the same as those submitted to Mr. Daniel Turner (*vide* p. 13 et seq.)

BOURNEMOUTH CORPORATION TRAMWAYS.

Mr. Bulfin's Views on the Conduit System formerly existing in this City.

The conduit system of tramways was installed in Bournemouth in the centre of the town in 1902, the total length being 3¾ miles of single line. The cost was three times that of the overhead trolley system.

It became necessary in 1910, owing to its dangerous condition, either to renew the conduit system, or convert to the overhead trolley system, and in view of their experience, the Corporation decided to scrap the conduit system, the reasons being, its high cost of installing, high cost of maintenance and upkeep, practically 50 per cent. more than the trolley system, its unsatisfactory running conditions (continuous breakdowns and delay to traffic).

The conduit system adopted in Bournemouth was the side slot, and was in the centre of the tramway system, the lowest part of the town. It was subject to constant flooding in storms, which short-circuited the system, and rendered it useless. The side slot was a constant danger to other vehicular traffic.

Under no conditions would the corporation with their experience recommend the conduit system in a busy thoroughfare, and where there was any danger of heavy floods. It was mainly on the experience gained here that the City of Edinburgh, and the Borough of Hastings decided not to install the conduit system.

ANSWERS OF MONSIEUR VERGNIOLE (ENGINEER TO LA SOCIETE DES TRANSPORTS EN COMMUN DE LA REGION PARISIENNE) TO THE QUESTIONNAIRE ADDRESSED TO HIM BY Mr. ALEX. CAMERON, IN DECEMBER, 1923.

Questionnaire.

Question.	*Answer.*
1. Number of kilometres of conduit system in operation ..	About 150
2. Number of kilometres of overhead track in operation ..	About 800
3. Average capital cost per Km. of conduit system based upon the present labour rates	One Km. straight single track on a conduit system—980,000 Frs. One single-track turn-out on the conduit system—48,000 Frs. One single-track crossover on the conduit system—30,000 Frs.
4. Average capital cost per Km. of overhead trolley system, based upon the present labour rates	One Km. of track (only) in the road—450,000 Frs. One Km. of track only, at the side of the road—310,000 Frs. One single turn-out when the track is laid in the road—17,000 Frs. One single turn-out when the track is laid at the side of the road—15,500 Frs. Overhead Line—carried on steel poles— Per Km.—45,000 to 65,000 Frs—according to the distance between poles and the strength of poles
5. What operation has been the most costly in the construction of the conduit system due to special circumstances and obstructions, such as sewers, water and gas pipes, and the like	The obstructions encountered in the construction of the conduit can considerably increase the average prices given above The increased cost due to the entrances to the Metropolitan Underground Railway have increased the construction considerably It is not possible to state what this increased cost has been in any particular instance
Cars.	
6. What is the total number of cars in service daily ..	Two lines only are equipped entirely on the conduit system. Fifty-one lines are equipped entirely with the trolley system. The greater part of the lines (68) in general, those in which the traffic is most intense, in the centre of Paris, are run on the conduit system, and the rest on the overhead system
(*a*) On the conduit system	Cars running on the conduit system only— 70 motor tramcars 20 trailers
(*b*) On the overhead system	Cars running on the overhead system only— 600 motor tramcars 300 trailers
(*c*) On both systems	Cars running on both systems— 1,200 motor tramcars 590 trailers Totals—1,870 motor tramcars 910 trailers
7. What is the proportion of cars being overhauled as compared with the total number	The repair shops overhaul 81 cars per month The ratio of the number of cars being overhauled to the total number in service is about 6½ per cent. for the motor tramcars and 5 per cent. for trailers
(*a*) Operated on the conduit system .. .. (*b*) Overhead system (*c*) Both systems	The method of construction, whether conduit or trolley, has no influence on the frequency of the overhauls, this being determined by the number of kilometres run
8. What is the average cost of a kilowatt hour	The average price of the K.W.H. varies with the price of coal. For a price of coal of 100 Frs. per ton, the average price of the K.W.H. for the system will be 0.294 Fr. This being the price of the K.W.H. on the low-tension side of the sub-station busbars

Question.	Answer.
9. What is the average cost per car mile on the conduit system	The cost of a car kilometre is practically the same on the conduit system as on the trolley system, and amounts to about 2.22 Frs., being about 2.48 Frs. per kiolmetre for the tramcars and 1.34 Frs. for trailer kilometre
10. What is the difference in maintenance cost of permanent way and rolling stock on a conduit system as compared with that on an overhead system	*Tracks*—The maintenance cost and the cleansing of the conduit per kilometre of track is about twice that of the maintenance of the trolley track, but the traffic being about twice as intense on the conduit system, the maintenance cost per kilometre car is sensibly the same on either system *Rolling Stock*—From the point of view of the maintenance of the rolling stock, we have not been able to note any important difference between the cost on the two systems, the greater number of cars circulating alternately on either system However, the traction on the conduit system is a source of more frequent short circuits due to the contact shoe being earthed by the rain and particularly by snow, and the salting of the track at such times. In bad weather interruptions to traffic are more frequent on the conduit system than on the overhead system
11. What are the objections and difficulties peculiar to a conduit system as compared with an overhead one	The chief disadvantages of the conduit system are— 1. The high first cost 2. The high maintenance cost 3. The cost of keeping the conduit free from the accumulation of road dirt, &c., on the insulators 4. The increased cost of maintenance of the rolling stock due to frequent short circuits
12. Is the flooding of your conduits in the whole or in part a matter of frequent occurrence, and, roughly, what percentage of lost time is due thereto	The conduits are only flooded under exceptional circumstances such as those which occurred in 1910. Under ordinary conditions it can happen that the level of the Seine is high enough to allow of infiltrations of water into some of the conduits. This is overcome by pumping, without the conduit being affected
13. What is the minimum car mile density per car mile track which will justify the additional capital involved in laying a conduit system	The conduit system does not present any advantages from the point of view of construction, being much more costly to construct and maintain than is the trolley system The employment of the conduit system cannot be justified from the point of view of economy whatever be the density of the service
14. From an engineering and economic point of view, omitting the question of street amenities or street obstruction, can a conduit system be justified	No. Only the aesthetic considerations can lead to the construction of the conduit system
15. How do electric tramways compare with motor omnibuses for mass transportation in large cities from the point of view of efficiency and cost of transportation	The tramway is more expensive in first cost, but clearly more advantageous from the point of view of the cost of running The average price per car Km. is for the whole system 2.22 Frs. for tramway and 2.35 Frs. for the petrol buses The seating capacity per tramcar is very much greater than that of the omnibus. If the number of persons to be carried is great, the economy of transport by tramway car, as compared with that by omnibus, quickly compensates for the extra capital cost of laying the tracks
16. How do the costs of tramway and omnibus operation compare, taken on the passenger mile basis	The cost per kilometre per seat offered (without taking into account the capital cost of establishment) is— 1. For the petrol omnibus having 38 seats—0.062 Frs. 2. For the tramway car having 49 seats—0.050 Frs. 3. For the train (comprising motor-car and trailer) having 106 seats—0.036 Frs.
17. Are you aware of any conduit system in France having been abandoned and an overhead system substituted therefor, and if so, in which cities, and the reason therefor	In general, the tendency in Paris is to restrict the extension of the conduit system. Its use is strictly limited to a certain zone. Since the war this zone has not been rigorously adhered to, and the tendency is to establish an overhead system on certain routes which are actually equipped with conduit, the reason being the high cost which will be involved in putting the track into condition again
18. What is the average passenger carrying capacity of— (a) Tramcar (b) Omnibus	The capacity of the motor cars and trailers (new type actually constructed) is respectively 49 and 57 seats The capacity of certain motor cars of the double-deck type of the old system) is nearly 83 seats The capacity of the omnibus having 4 wheels is 38 seats, and that of the omnibus having 6 wheels, 48 seats We have under consideration light cars having 25 seats, with pneumatic tyres

Question.	*Answer.*
19. What is the average weight of— (*a*) tramway per passenger seat (*b*) omnibus per passenger seat	Motor Tramway Car, Type L—415 Kgs. Trailers—350 Kgs. Omnibus 38 seats, 48 seats, 6 wheels } 180 Kgs.
20. What is the proportion of standing room to seat capacity of— (*a*) Tramcar (*b*) Omnibus	Petrol Omnibus having— 48 seats—20 per cent. 38 seats—26 per cent. Motor Tramway Car, Type L—38 per cent. Trailer, Type A—58 per cent.
21. What is the life of a motor omnibus in service ..	The maintenance of these vehicles being so efficient, it is estimated that the life of these is indefinite. Only reasons of engineering progress can cause them to become obsolete
22. What rate per annum do you depreciate an omnibus	For the reasons given above, a vehicle continues in service indefinitely and always maintains its initial value
23. What is the average total cost of operation per omnibus mile	The cost of an omnibus Km. is actually 2.35 Frs.
24. What is the average total cost of operation per tramcar mile	
25. What is the average speed per hour— (*a*) Tramcar (*b*) Omnibus within the City of Paris	The commercial speed (exclusive of standing times in terminals) is, in Paris, 12 metres to the hour on an average, but this varies according to the density of the traffic and the time of the day
26. What is the average capital cost of— (*a*) Tramcar (*b*) Omnibus for a given seating capacity	The capital cost of construction of the vehicle and of the running sheds is as follows :— For Tramcar, Type L—480 Frs. per seat per year Trailer, Type A—380 Frs. Petrol Omnibus— 38 seats—390 Frs. 48 seats—300 Frs. It is necessary to note that the proportion of places to the total number of seats offered is greater for the omnibus than for the tramcars
27. What is your method of heating your tramcars and omnibuses in cold weather, and in the case of tramcars, the units of electricity used per hour of service	The tramcars are heated by electrical resistances enclosed in aluminium covers. These resistances are mounted in series, and consume about 900 watts per hour of service. In a Type L tramcar, there are eight, each having a resistance of 36 ohms, and four having a resistance of 18 ohms For the omnibuses, heating is obtained by the circulation of the exhaust gases, in aluminium tubes
28. What is the chemical composition of— (*a*) Tramway rails (*b*) Points and crossings	*Rails*—The mechanical characteristics of the metal are only given to the makers. We use some rails made of "Thomas" or "Martin" steel, the latter being found more durable Points and special curves of small radius are made of manganese steel, having 12 per cent. to 15 per cent. of manganese
29. Do you use sorbitically treated rails ..	We are making a test on a length of 300 metres of double track of rails, which have been submitted to sorbitic treatment by the Cie de Chatillon Commentry We are also testing rails treated under the Sandberg process These tests have not been in hand long enough for us to make any statement as to the relative results
30. Can you give the approximate statement of earning capacity and saving in cost of operation of coupled cars with multiple unit control as against single car operation	The saving is considerable The cost of a Km. motor tramcar only and of a Km. trailer car, having about the same seating capacity, shows a saving in the neighbourhood of 1.14 Frs., being approximately 45 per cent. of the cost of the Km. motor tramcar The economy resulting from the employment of trains, comprising motor and trailer, compared with two motor tramcars having the same seating capacity, should be in the neighbourhood of 25 per cent.

MEMO.—The answers to the Questionnaire are based upon the approximate average value of the Franc at 83 to the pound sterling.

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