AUSTRALIAN AND NEW ZEALAND TRAMWAYS CONFERENCE.

CONFERENCE ROOM 4TH FLOOR, BANK OF NEW SOUTH WALES CHAMBERS, 7 WYNYARD STREET, SYDNEY, MARCH 1934.

The undermentioned undertakings accepted the invitation to the Conference held as abovementioned and were represented by the following:-

ADELAIDE:

Sir William Goodman, Chief Engineer and General Manager, Municipal Tramways Trust.
Mr. E. H. Bakewell, Chairman, Municipal Tramways Trust.
Mr. J. R. Cain, Member, " " "
Mr. J. L. Leal, " " " "
Mr. E. G. Whittle, " " " "
Mr. F. L. Parsons, " " " "
Mr. R. O. Pitcher, " " " "
Mr. C. R. Moyes, Secretary and Assistant Manager, "
Mr. C. F. Hursthouse, Rolling Stock Superintendent, "
Mr. E. W. McEgan, Chief Clerk, "

AUCKLAND:

Mr. G. Grey Campbell, Member, Auckland Transport Board.

BRISBANE:

Mr. G. R. Steer, General Manager, Tramways Department.
Col. J. M. Grant, Chief Assistant Engineer, Tramways Department.

DUNEDIN:

Mr. W. H. Mackenzie, Manager, Dunedin City Corporation Tramways.

HOBART:

Colonel S. H. Hancox, Manager and Engineer, Hobart Municipal Tramways.

MELBOURNE:

Mr. Alex. Cameron, Chairman, Melbourne and Metropolitan Tramways Board.
Mr. G. Membrey, Member, " " " "
Mr. J. V. O'Connor, Member, " " " "
Mr. T. P. Strickland, Chief Engineer, " " "
Mr. A. D. Murdoch, Manager, " " "
Mr. H. Stephenson, Assistant Rolling Stock Superintendent, "
Mr. G. G. Jobbins, Engineer and Manager, State Electricity Commission, Victoria.

SYDNEY:

Mr. S. A. Maddocks, Commissioner for Road Transport and Tramways.
Mr. C. N. Neale, Chief Traffic Manager.
Mr. H. B. Edwards, Engineer for Workshops and Rolling Stock.
Mr. C. W. Keele, Engineer for Way and Works.
Mr. P. J. Timmony, Assistant Chief Traffic Manager.
Mr. T. Ashcroft, Mains Superintendent.
Mr. D. H. McBurney, Rolling Stock Superintendent.
Mr. C. H. Parkes, Accountant.
Mr. G. Sargeant, Manager, Departmental Omnibus Services.
Mr. W. S. Corner, Assistant Chief Electrical Engineer, New South Wales Railways.
Mr. M. J. Lacey, Engineer of Tests, New South Wales Railways.
Mr. F. A. Maclean, Designing Engineer, Electrical Branch, New South Wales Railways

and other officers of the Department of Road Transport and Tramways as opportunities offered.

The Use of the Trolley Slide by the Melbourne and Metropolitan Tramways Board.

(T. P. Strickland, Melbourne.)

The sliding shoe form of current collector has been tried at various times over a period of years and eventually the conclusion arrived at was that the behaviour of the shoe was not satisfactory when the shoes were operated amongst trolley wheels.

Late in 1932 it was decided to equip all cars, 15 in number, on an isolated part of the system at Footscray with a set of fittings called the "slide" supplied by the Economy Devices Co. of Chicago. The shoe has a renewable wearing piece or insert of chilled cast iron and makes a greater longitudinal contact with the wire than previous types. Between March and December, 1933, these cars had run 313,332 miles using 129 inserts, giving an average life of approximately 2,500 miles.

LUBRICATION.

From our previous experience it was found that it is essential to lubricate the trolley wire and probably the best method is to use a graphite stick held in an apparatus, called by the above Company a "slicker". This device is attached to a trolley pole of a car not carrying passengers and is travelled over the lines when the lubrication is required.

This form of lubrication will deposit a film over the wire providing the stick is made to a certain formula and is suitable for the climatic conditions at the time. The free movement of the stick in the slicker and the application tension is also very important. It is found that the graphite lubricant is most satisfactorily retained on straight track as might be expected.

We notice that the surface is not so good on worn wire as on new or full section wire owing to its failure to retain the lubricant so effectively, no doubt on account of the increased

contact pressure per unit area. The trolley pole pressure is 10 lbs.

Another rather extraordinary feature observed is that 3 or 4 portions of a bay of wire here and there fail to retain the grease film and consequently begin to wear while the wire on either side is well lubricated, although all received the same treatment. We have not yet found a satisfactory explanation of this difficulty.

As the wire at curves suffers most wear by the wheels or shoes, we find a corresponding effect on the life of the grease and it is the state of lubrication on curves that determines the frequency of application of the slicker.

As there is a large number of curves on the section under review we find it necessary to carry out this operation once each week.

WEAR.

We find that on the straight or large radius curves the wire takes a very smooth and burnished surface and very little wear takes place. With a line of this nature and free of small curves it is considered that the periods between lubrication could be extended.

The life of the renewable inserts of the slide averages 2,500 car miles, the inserts cost 1/5d. each.

Trolley wheels on the system now fitted with shoes averaged 28,600 miles per wheel, the total cost of wheel, bush and returning being 17/-.

Trolley wheels on the rest of the system run 17,000 car miles at a cost of 17/- each, including part cost of the bush, one bush doing two wheels.

OVERHEAD FITTINGS.

The sections of trolley wire in use here are No. 3/0 B.S. and 4/0 S.W.G. non-fouling and grooved respectively. The slide

passes under ears and fittings in a most satisfactory manner with a minimum of arcing.

The operation over frogs has presented some difficulty up to date. We use on trolley wheel lines a frog with a gap of about 13" in the centre between tongues, which gave unsatisfactory results with the slides.

We find that the type of frog giving the most reliable results is one having the centre ends of the tongues close together, and these tongues deep enough to prevent the flanges of the slide from touching the frog pan except for the period of transition from one tongue to the other. It is necessary also in setting poles on cars, to see that the slide is vertical and in line with the longitudinal axis of the car.

SUMMARY.

It should be borne in mind that this trial is being carried out on a system equipped with one-man light cars and the result that would be obtained with the heavier bogie cars is, perhaps, a matter for conjecture at this stage, especially as we have a large and a small section trolley wire to deal with in other parts of the system.

The conclusion arrived at to date is that for long lines of tracks free of small curves the use of the slides would show a considerable reduction in trolley wire wear, with the elimination of wearing strips or envelopes and consequent saving, at least, where small cars are used.

As previously mentioned a number of small radius curves do appear to reduce the efficient use of the slide by the effect on the lubrication.

Use of the Fischer Bow.

Fischer bows are fitted on 3 cars operating in Holden Street, Fitzroy, on a shuttle service. These have been in service for 3 years. The plates average 22,000 miles each and

the cost is £2.2.6 each. These plates are greased daily, and cleaned down thoroughly once a week and filled with new grease. The lubricant used is a mixture of yellow grease, tallow and engine oil.

Comparison of Costs.

Trolley wheels on Footscray system	7d.	per	1000	miles
Shoes "	7d.	"	"	"
Fischer bow plates "	23d.	"	"	"
Trolley wheels on rest of system	12d.	"	"	"

The above figures are for wheel, shoe and plate replacements only.

Chairman: I think it was laid down that copies of all papers should be distributed beforehand in order to give the Delegates an opportunity of preparing matter for concise discussion on the various points. However, we would rather have a valuable discussion of this kind without the notes beforehand than not have the discussion at all.

Mr. Strickland: It is submitted for information rather than discussion.

Chairman: We would, I think, show very little appreciation of such a valuable paper if it were not discussed and I am sure there are quite a number who would be very glad to take part in the discussion, and all members of the Conference, particularly lay members like myself, would be very glad to hear what the engineers in other systems have to say in regard to this important subject.

Mr. Hursthouse: In Adelaide we have tried out slides or shoes to some little extent, and from reports it appears they are being tried out in Christchurch where, they say, results are encouraging. Auckland reports them to be unsatisfactory. Melbourne has them on trial and Sydney reports having tried them some years back without success. In Adelaide they were tried some 14 years ago, but without lubrication and were found unsatisfactory.

We have at Port Adelaide an isolated system operating small four-wheeled cars, and on this we have tried out trolley shoes of two or three different kinds. One design of our own manufacture was an oval wheel with a centre set eccentric and a hardened steel inset. This was reversible in that it could be taken out and turned upside down and a second steel inset used. All three classes we tried with lubrication, such lubrication being limited to hand dressing the wire. Our experience has not been altogether successful, but it is yet rather early to condemn it indefinitely. We are running it on round wire which has been in service for a number of years with enveloping fittings, which are definitely against satisfactory operation.

The slides or shoes give a very fine smooth finish to the underside of the wire but tend to bruise the same after leaving the envelope fittings.

Mr. Strickland mentions the absence of noise when using shoes, and I am certain anyone who has watched their operation would be surprised at the definite reduction in noise, showing how much trolley wheels and poles contribute to the general noise of the tramcar. Personally I think the success of the shoes will only be made provided the trolley wire has a smooth under run and lubrication is definite. I do not think there is much limitation to the size of car that can be run with shoes.

Possibly pantographs or Fischer bows would be an improvement on the shoes, and where heavy weight cars collecting say 600 amperes from the line are run the pantograph seems preferable to any intermediate collecting device.

Col. Hancox: We have been rather interested in the question of shoes because we are using the Fischer bows, and we have a proposal to run a trolley bus using the same wire. I think

it would be almost impractioable to use wheels on the same wire as the Fischer plate so we have considered the question of using the shoe. We have not tried any of them but we have had a sample of the Ohio Brass Company's swivel head shoe, which is now used extensively on American trolley buses. I am very much surprised at Mr. Strickland's figures in not getting a higher mileage out of the Fischer plates. Our average for the last year for the whole of our cars was about 45,000 miles per plate. Mr. Hursthouse mentioned about the corrugations on the wires. We use Brown and Sharp 2.0 non-fouling section. We did have a good deal of trouble. We were not using the Fischer plates but the old aluminium bows and suffered from bad corrugations under the suspension points. We got rid of it pretty well altogether by making the suspension more flexible. That seems to be a very important point with any sliding contact of that sort - to get it quite flexible. One of the most important points of all is the class of lubricants used. The great difficulty we had was the lime base in ordinary grease. The Fischer plate has the two slots in which the grease is put. The aluminium bows had the same. After rain they were liable to have a groove cut across the aluminium. This was due to the grease being washed off the wire by the rain. Then we used different lubricants. One of the best we found was the Keystone, and we have since tried one somewhat similar to that which Mr. Strickland mentioned. This has a good deal of tallow in it and will stand the water. Then we used Vacuum cup grease, and now we are using Wakefield grease with satisfactory results.

Mr. Strickland: I think one of the explanations of the shorter life we get with the Fischer plate is that we have to run it over a section in which trolley wheels are running. It is run on the shuttle service, but the car has to run to a shed over a mile and a half or more away, and the consequence of running to and from this shed is that some of the damage is done which leads to reduced life. Also other cars are liable to run over the section on which this runs.

Chairman: On that question of the trackless trolley, I might state that we had advice only the other day from Chicago, to the effect that there is almost a general replacement of wheels by shoes in the American system, and we were advised that in only three systems in America are wheels being used. They fitted their overhead, in the first place, for the wheels and they have now realised the advantage of the shoe to such a great extent that they are proposing to adopt it.

Col. Hancox: There is one thing I might have said and that is in considering the life or comparing the Fischer plate with the wheel, the saving in wear on the trolley wire should be taken into consideration. We found in the last figure just before we came away that our wear on trolley wire is steadily decreasing - an outcome of the better lubricant, I take it.

Mr. Ashcroft: I was very pleased to hear Mr. Strickland's remarks, but I would like to have heard a little more from the overhead wiring point of view. Mr. Strickland dealt mostly with the shoe from a rolling stock point of view. I noted with pleasure that the test on shoes that Mr. Strickland made was conducted where wheels were not used. I think that is very necessary. In all information we have received in connection with tests of shoes it has been emphasized that the shoes must be tested independently from wheel operation,

Mr. Hursthouse mentioned that at the recent rolling stock conference it was stated that Sydney had tried out these shoes without success. I did not have anything to do with that test, but I should say that that test was no good. It was conducted on lines on which wheels were mostly used and therefore was not a proper test. One of the major troubles was, I believe, the shoes would not reverse, but I understand that trouble has been overcome in the modern designs. Personally, I think that to give a shoe a proper test we should do it the same way as Mr. Strickland - on a line that is entirely free from all wheel operations. I should suggest a test in Sydney on the Ashfield - Burwood - Mortlake line, which is entirely isolated from the other lines and where we have about 23 cars to the 15 mentioned on the test line in Melbourne.

Mr. Strickland referred to the life of the shoe. That is a point I do not know much about.

The lubrication of the wire is a very important subject. Most people say that if you use a trolley shoe you "have to" lubricate it. I think "have to" should be changed to "able to", because lubrication of trolley wires in my opinion is a very valuable preventative to wear. Where trolley wire can be successfully lubricated and you can maintain that burnishing of the contact area you have cut out the troubles from wear. Unfortunately, you cannot do much good with lubrication of the wire where trolley wheels are used. I do not think it is worth while, but we have not quite given up hope. We have experimented a little, but not in a proper way. We just got some sticks of graphite and rubbed the mixture on the wire by hand.

Mr. Strickland's next remarks concern the pole pressure. I think from the overhead wiring point of view that is a point that should be considered. We had in our tramways to increase our pressure from 18 to 25 lbs. and we still find that we get excessive arcing between the wheel and the wire. I do not think if we went up to 30 lbs. we would cut out that arcing. But the shoe can be operated at 10 lbs. pressure, and with the added advantages of lubrication saves an enormous amount of wear on the wire and costs of renewals.

Mr. Strickland mentioned the 4" grooved wire. Like Adelaide we use round. I think we are wrong and that grooved wire should be used in Sydney. Mr. Hancox referred to corrugation. We have had quite a lot of corrugations in the trolley wire and suspension fittings on the Wynyard to North Sydney line, that is, wheel operation. But I feel certain Mr. Hancox's explanation of heavy suspension fittings being the cause is correct. In my opinion the bulk of the corrugations in Sydney is due to these heavy fittings with large porcelain insulators at suspension points. We have removed these from some suspension points and found they weighed 9 lbs. We are replacing them by a spring look hanger weighing about 2 lbs. and feel confident this change will remove the trouble.

We have in Sydney been using for many years a 4" trolley wheel which, in my opinion, is not satisfactory for the work. I would say that where the average schedule speed does not exceed 9 miles per hour, trolley wheels are quite satisfactory. We proved that by certain outlying sections of our lines where traffic is light. But when we come into the first and second

sections, particularly where we do get a chance to speed and we are drawing very heavy currents, our trolley wire renewals are enormous. Prior to 1931, before we had such high speed, we renewed about 27 miles of trolley wire per annum. Our total track mileage is about 300 miles. In 1932, we found we were having a lot of trouble and decided to clean up, and we renewed 80 miles at a cost of nearly £16,000 or £198 per mile. There were 618 renewals, and the average length was 684 feet. We were rather fortunate that time that the price of copper was somewhere about £28 or £30 a ton. To-day it is about £35, but had we had to renew that wire some other time at £60 or £70 a ton, the cost of course would have been a much greater burden. That was 1932. In 1933, we expected that after erecting that 80 miles we would have an easy time. We thought we had got rid of most of the trouble and taken out most of the original wire and that we were going to be quite alright. It might be mentioned that we had original wire that had been up 15 or 20 years. From 1910 to 1917 we put in a lot of new lines, and after the usual 20 years' life we found that extensive renewals were necessary. Also many miles of trolley wire which was purchased abroad was failing, and we did not like to leave it up in important sections, so we took it out. We were surprised last year to find that trolley renewals had not decreased to any great extent. The renewals of this last year totalled about 60 miles, and we were compelled to look for the cause. So far as I can see, under the existing traffic conditions, the 4" wheels are the main cause. These 4" wheels cause excessive arcing between the trolley wheels and the trolley wire, and in my opinion the excessive arcing is more conducive to trolley wire wear than the actual mechanical wear. I would like to refer to an article I have just perused by Mr. Nelson M. Powell, the General Manager of Boston, Revere Beach and Lynn Railroad, Boston, Massachusetts, on page 280 of the September, 1933, issue of the "Transit Journal", showing that wheel operation gave 7 or 8 times the amount of wear compared with the shoe. I would like also to refer to a rather interesting experiment which was conducted for the Hanshin Electric Railway Company, Japan, by the University of that city. It took a comparison between trolley wheels and pantographs. Without going into any details, it showed the wear due to the pantograph was 1.4 times greater than the trolley wheel. There is not very much detail in the article but I think it is well worth further thought. Other people besides these in Japan and America have studied this matter closely and we should, I think, benefit by their experience and tests.

Referring again to Sydney, the arcing that we are getting with the pitting and burning of the wire should, I think, be commercialised in some way. What does it cost us? If we allow the arcing with pitting and burning of the wire to go on we can put the cost down to at least £5,000 per annum and I would say that is a low estimate. With good current collecting apparatus we should reduce our trolley wire renewals to 25 miles per annum or less. We are now renewing about 50 miles. That would be a saving of 25 miles at say £200 per mile, which is about £5,000 and I am quite sure that that is quite possible. The reduction in noise and in radio interference would be appreciated also by the public. With regard to the other savings in current collecting gear, such as Mr. Strickland has mentioned, we have not had any experience of the pantograph, but I have read with interest something of the operation of bow collectors in Hobart and Mr. Steer's remarks

about the Fischer bow, and I have just had the pleasure of reading an interesting article by Mr. McKinnon, the General Manager of the Glasgow Corporation. I think Mr. Steer has also referred to that. The reason why Glasgow replaced wheels by pantographs was stated briefly "that the wheel was not a safe and efficient collector at high speeds." Glasgow, I think, had an average speed - what they call schedule speed - of 9.8 miles per hour. Sydney has something like 12.17, but I think if we only had 9.8 to contend with we would not worry very much, but at 12.17 it makes us do a little more thinking. I am not quite sure, but I think we are higher than Melbourne and Adelaide. I know some time ago the average schedule speeds were:- Sydney, 12.17; Melbourne, 11.31; Adelaide, 10.47; and Brisbane, 9.88, so that Sydney has a higher speed and much higher than Glasgow and other cities and it looks as though we have to do something as they did in Glasgow to overcome our difficulties. I cannot say much about comparisons in the sheos. So far as Sydney is concerned, we have gone perhaps too far to change over to pantographs, but I think it would well pay us to consider the matter. Glasgow, as far as I can make out, spent a huge sum of money in the conversion and I have not heard yet whether they overcame their troubles. I think Mr. Steer mentioned that they were still getting extensive arcing at the suspension points, and I do not think Sydney wants to spend a lot of money and then find we are in the same boat. We would like to be sure. I think Sydney therefore appears to be committed either to the trolley wheel or the shoe. In my opinion, the 4" wheel, which is practically our standard wheel - we are using a few 6" wheels but not very many of them, also the "R" type car has a 6" wheel - is undoubtedly unsuitable for Sydney conditions and we must quickly decide on either a large and more modern wheel or a shoe which appears to be the ideal collector. The very fact of the low pressure and the long point of contact between the shoe and the wire are very great assets, and for Sydney should be the ideal thing for our high speeds and heavy current collection. We, as I have said, have committed ourselves to round trolley wires. Mr. Hursthouse has mentioned that in Adelaide they have been trying trolley shoes with round wire and that they are not very satisfactory. Personally, I do not think we would get much satisfaction by using shoes with round trolley wire. It is waste of time in my opinion, but I have not had very much experience with them. It would not be a very expensive matter to change over from round to grooved trolley wire. One of the great advantages of using grooved wire, which Mr. Strickland realises, is that you can use different size sections, and I think in places like Pitt and Castlereagh Streets where we have only an 0.4" wire and very dense traffic - I do not suppose it is any heavier anywhere - we could use a much larger section of trolley wire without having to alter any of our fittings. The grooved wire, with the standard groove for all sizes of wire, can be used without changing fittings, which is a very great advantage. If we want to put up bigger wire in Pitt Street now we have to change our mechanical ears and a number of different fittings, and I think the object of every engineer is to cut down the number of fittings which is used in the overhead wires, so I think Sydney if it wanted to use shoes, would be well advised to change to grooved wire.

I do not think there is anything further I can add, but I am very pleased to have heard Mr. Strickland's remarks. I would like to have heard more about the trolley wire side of it. I was in Melbourne and pleased to see that burnish

on the wire the result of the lubrication, and I am quite sure that where they have that burnish any troubles with the trolley wire from wear will be very small.

Mr. Murdoch: It does show that this is one of those problems in which there are a number of independent opinions and it makes it very difficult to take the experience of one place and say that there should be a similar experience in another place. If you were to ask a conductor what he thought about the whole affair he would say the trolley pole is a confounded nuisance. He would not be far wrong, and I think that is the experience of engineers. They are endeavouring to get some relief from it but I do not think they have got very much relief so far. One wants one thing and the other wants another, and each has its place. If we can devise some system of overhead collecting gear which will reduce noise, which will reduce wear, which will relieve the conductors of this continual replacing of the trolley pole on the wire then we shall have done good work. The experience in Sydney does show that in addition to the overhead wire there is the track itself. The track is not in any way in a wonderful condition, and if the car is continually dipping up and down then the trolley poles have to respond to it and a higher pressure is required to keep the pole on the wire. You have to take that into account. We are not getting the life out of the pantagraph that we should get, but in Birmingham they have sections there in which the pantagraph was running over the same wire as the trolley and they said they had no difficulty at all, but they had a lubricating system with a great big drive underneath the shoe. I asked what life they obtained and was informed they did not know, as they measure it in years not in car miles. So you see there a different set of conditions again, and I think it is very desirable we should look into the improvement of the overhead trolleys, but don't forget that what may be good in Melbourne might not suit Sydney and we have to take everything into account, not only the cost but the reaction on the overhead and the track itself.

Mr. Steer: Without being in any way competent to speak on the engineering side of this question I know that in Glasgow where they went over to the Fischer bow they found the results disappointing until they altered the overhead and made it much more flexible. I tried to find out how much they had spent but I could not get at it. I asked what the result was as regards the saving in wear on the trolley wire but their experiments were not complete. Mr. McKinnon promised to send me the information later on. Sunderland had the same experience. They started to put in the Fischer bow and they got a flash at every span wire. There again they are making their overhead work far more flexible and of lighter material, not only so but Glasgow developed a special flat-bottomed trolley wire in order to suit the Fischer bow. They are pleased with the results according to what Mr. McKinnon wrote in an article on the subject lately, but it would be interesting to know what it cost.

Mr. McBurney: A couple of years ago we made a test with a trolley shoe. It was a steel shoe, running on one car on the Enfield system. There were about 22 or 23 cars running on the same system with wheels so that I suppose that was not an altogether satisfactory test. The overhead wire was not lubricated. We got a mileage of 19,800. With regard to the shoes being unsatisfactory in Sydney, I think that is due to the failure to run backwards satisfactorily, but during

that test which I just mentioned I did not hear any complaints from the Traffic Branch so I presume that when they wanted to go backwards they used the other pole.

Mr. Keele: I am very glad to hear that Mr. Strickland has made reference to the lubrication of the wire. To indicate the benefit from lubrication, the Railway Department at the present time has evolved a scheme for lubricating rails. On the City Railway where renewals of manganese rails every six months were taking place, it is expected that the life of a similar type of rail lubricated will be seven years. In the Tramway Department one of these lubricators has been installed at Wynyard Station on the crossover at the terminus, and if any members of the Conference would like to see this device I would only be too pleased to show it to them. It is a similar device to that in use in the Railway Department, except that the tongues, which come in contact with the tramway rails, are slightly amended to suit tramway conditions. The lubrication of the gauge side of the rail in the Railway Department at the present time, has been so successful that the Chief Civil Engineer has even offered to sell me manganese rails because he does not propose to use them in future. He proposes to substitute the carbon steel rail where he has been using manganese on account of the anticipated long life of the carbon steel.

Mr. Edwards: We did make a trial many years ago in Sydney with the Miller shoe and it was most unsatisfactory. The early aspect of the test was so good that the Department went to the expense of ordering a couple of hundred but as the life of the shoe continued the trouble became worse. The mileage obtained, as quoted by Mr. McBurney, was about 19,800. I might add that with the wheel that is now used on the "R" type car we are getting in the vicinity of that.

Mr. Strickland: Mr. Chairman, all I want to say in reply to Mr. Ashcroft's complaint is that I have not dealt with this from the point of view of the overhead. I explained at the outset that it was submitted for information. It was not supposed to be a comprehensive paper. Also there is the point that these things were prepared by the Overhead Department and not by the Rolling Stock Department so that it is taken from their point of view. The old type of Miller shoe was tried, of course, as Mr. Edwards said, many years ago, but the present shoe has a somewhat different head in that the point of rotation of the shoe has been altered so as to get a more parallel operation. Neither of them is successful unless run on a line on which no trolley wheels are used.

Chairman: I take it there is no further discussion on the paper. We are indebted to Mr. Strickland for the information that he has given us and we will be very interested indeed, Sir William, to hear the result of your experiments in due course. I take it you will make it available to the various entities attending the Conference.

Sir William Goodman: Yes, Mr. Chairman, I will let you have our experience of the trolley shoes and I would like to inform you that we have decided to equip some of our cars with pantographs. We run up to 45 miles per hour on the Glenelg Railway, and as the result of my experience in Europe I have decided distinctly in favour of the pantograph in

preferenoe to the bow oolleotor beoause the vertioal aooeleration is so muoh better.

We will let you have partioulars of that as soon as we get any information whioh we oonsider reliable.

Handling of Heavy Traffio on Speoial Oooasions - Sydney Tramways.

Mr. Timmony read his paper on this as follows:-