

SOME COMPARISONS BETWEEN BRITISH AND AMERICAN RAILWAY ROLLING STOCK.

*Paper read before the Institution by R. W. REID, Derby,
on 24th March, 1921, at Glasgow.*

Paper No. 104.

Towards the end of 1919 the Author had an opportunity of visiting Canada and the United States, primarily to study the practice of the American railways and private builders in the construction and maintenance of rolling stock. Some of the principal workshops and repair depots belonging to the railway companies were visited, and, in addition, the workshops of some of the private builders of locomotives and rolling stock.

Before discussing the various types of vehicles used for passenger and freight service in America, it is necessary to point out some of the differences which exist between American conditions and those pertaining to this country and which influence the designer.

To anyone who is not familiar with the conditions obtaining in America the first explanation to be made is the difference existing in the personnel on the railways and particularly in the workshops in that country and in ours.

In pre-war days the rate of immigration in America was about 100,000 per month. Most of these immigrants came from Europe, and they included representatives of every European race. In addition to immigrants from Ireland and Great Britain who only represented a small percentage, the following emigrated in large numbers to the United States particularly :—Italians, Greeks, French, Germans, Austrians, Poles, Czechs, Serbians, Roumanians, Turks and so on. This great flow of alien labour is represented in the workshops of the country. It is no uncommon thing in walking through a big American workshop to find the shop notices posted in seventeen or more languages. These people have their own newspapers, which are published in big towns, and in Detroit, for example, 80 per cent. of the workers are of alien birth.

This point has a bearing on the equipment and organisation of an American workshop, the first principle of which is that the operations must be specialised and that the machinery is so arranged that with a few days' training any man with ordinary intelligence can perform what is very often in this country considered to be skilled work. The products of the factories—whether they be motor-cars or railway rolling stock—are standardised to a degree, and are designed to eliminate wherever possible hand labour in their manufacture and, incidentally, to facilitate their repair.

A great deal has been said of the economies which would result from the introduction on to British railways of the high-capacity wagons such as are used in America. These statements are frequently made without reference to the difference in the physical conditions of the two countries. There is really no insuperable difficulty about introducing in this country the high-capacity wagons assuming that the traffic conditions warrant their adoption, except that of expense, but it is very doubtful if the resulting economies would repay the capital outlay necessary, as these economies are based on assumptions drawn from American statistics obtained under totally different working conditions. By reason of the fact that our merchandise wagons have to enter into all sorts of works and sidings, and even be carried on hoists between the floors of goods warehouses, the introduction of a long bogie vehicle generally is impossible in this country without incurring a great deal of expense, and

therefore it looks as if the four-wheeled British vehicle will remain the standard for many years to come. This contention is borne out by the fact that quite recently extensive inquiries have been made throughout the railways in Great Britain with the purpose of obtaining information to enable the Railway Clearing House Committee to produce a design of a standard wagon to be used in this country. The result of these inquiries has shown that it is impracticable to put into general use wagons which have a greater length than 17ft. 6ins., or a greater width than 8ft. 6ins.

The first impression the visitor gets of American rolling stock is that the units are much bigger than ours, the trains are longer and heavier, and the locomotives are colossal.

Referring to a map of the United States, the greater distances from the manufacturing districts to the sources of raw material and to the points of shipment will be appreciated. The extreme distance from East to West is over 3,000 miles—practically the same distance as from New York to Liverpool. If this is compared with a long run in this country—say London to Aberdeen—one of the great differences in their operating conditions will be realised.

The bulk of the traffic, however, is not carried such great distances, particularly since the Panama Canal has shortened the sea route from the Pacific Coast to Europe. Still, the big manufacturing districts are in the Middle West, the coal and iron is in Pennsylvania and Norfolk, and the agricultural districts south and west of Chicago have to send their produce to the eastern seaboard for export. Or, to refer to Canada—where the Canadian Pacific Railway is one of the most progressive and best-managed railways in the world—the grain has to be brought from the West to Montreal for shipment, and the British Columbian produce all the way across from Vancouver. Then it must be realised that this traffic is of great dimensions, and therefore specially large vehicles can be usefully designed for handling it. In short, the American railways are wholesale traders and the British are retail.

Freight Stock.

It is common knowledge that all over the American continent the rolling stock is provided with automatic couplings, being so arranged as to form a central draw and buffing gear (Fig. 1), and the design, therefore, differs radically from that of British wagons, which are provided with side buffers. The strength of the American wagon is

provided by two main central girders running the whole length of the vehicle and to which the automatic coupler is attached (Fig. 2). The automatic coupler must be considered an improvement in many ways on the loose coupling used in this country, but the latter makes it possible for the locomotive to be built within the limits put upon the locomotive departments and to haul a much longer and heavier train than would be possible if the train were tight-coupled. The freight trains in America are not run at such high speeds as in our country, but gigantic locomotives, capable of hauling very long heavy trains, are employed.

The standard wagon in America for general merchandise traffic is a 40-ton bogie covered van, which is about 40ft. long and weighs about 20 tons. This vehicle is used for practically every class of material except coal, for which special coal cars are employed. There are also a good many low-sided wagons, which are used for carrying plates and rails; they are open wagons, with sides 3ft. high. Very few special vehicles—such as trollies, deep case wagons, implement wagons, and so on—which are so familiar on British railways, are required in America, because owing to the loading gauge being so much bigger it is rarely necessary to provide anything more than the ordinary vehicle for loads which have to be carried on special vehicles in this country.

It is a Government requirement that on freight trains all cars must be fitted with the Westinghouse air brake and be braked to 40 per cent. of their loaded weights. It would be impossible to handle the long trains on the steep gradients without this.

All the freight stock runs on bogies, and the majority of the stock is mounted on cast-iron wheels. These wheels (Fig. 3) are made in foundries specially designed for the purpose, and the Author was informed that they have been sold at £15 per ton with a guaranteed life of five years, as against steel wheels at £29 per ton, which are said to give ten years' life, the prices being for delivery at the makers' works in U.S.A. The depth of chill on these wheels varies from 1in. to 9/16in. A great deal of prejudice has existed against their introduction over here, but now that a number of "W.D." wagons, constructed in this country with chilled wheels, are being returned to this country from France, it will be possible to get some experience of these wheels in running. The chief difficulties which occur are the breaking away of the flange and, of course, in time the wearing-out of the chilled face. This would not occur so quickly in England

as in America, because English wagons are not generally fitted with the automatic brake, and the cause of the break-ages on chilled wheels in America is that on the mountain roads it is no uncommon thing for the wheels to be red-hot when the trains arrive at the foot of the mountain. Chilled wheels need no turning during their life, and command a good price as scrap.

The box cars have steel underframes and wood tops, but owing to the damage which has been done to the ends of covered vehicles by the movement of heavy loads, it is now the practice to build these cars with corrugated steel ends, the one most commonly used being known as the "Murphy" steel end (Fig. 4). The end is usually in three pieces, with horizontal joints, and is made of $\frac{3}{4}$ in. steel plates with 4 in. corrugations. Some of the box cars have all-steel tops. They are all fitted with sliding doors, and wood ones are made both with single and double sides. The standard box car has a steel underframe and wood top, but the old cars have wood underframes. A certain number of all-steel box cars are now in use (Fig. 5); these are naturally more expensive and are also about 10 per cent. heavier.

The question of good loading for freight vehicles has received a great deal of attention in America, and directions are issued by the different railway companies to their operating staffs showing the best methods of loading various commodities. The Author obtained, whilst in America, some figures which it may be of interest to quote. These figures are for 40 ft. eight-wheeled steel underframe box cars, with wood tops, 40 tons capacity, tare 19 tons 15 cwt. The same car with steel top as well as steel underframe has a tare of 21 tons 10 cwt. The average loads are as follow :—

Tons. Cwts.				
Grain	...	...	32	5
Bituminous Coal	...	...	35	15
Ore	...	...	35	15
Fruit and Vegetables	...	...	11	10
Pressed Meat	...	...	13	10
Lumber	...	...	20	10
Agricultural Implements	...	...	10	15
Household Goods	...	...	3	10
Automobiles	...	...	4	10

The figures for the same railroad for general merchandise loaded in 1919 (averaged from stations loading 15 cars or more per month) are as follow :—

				Tons. Cwts.	
January	...	...	7	0	$\frac{1}{2}$
February	...	...	7	5	
March	...	...	7	8	
April	...	...	7	0	
May	...	...	7	0	
June	...	...	6	11	
July	...	...	6	12	

These figures were obtained in a district where a great amount of automobile traffic is carried, and it will be appreciated that with this class of traffic the best loading is not to be expected. The packing of these cars, however, is done very ingeniously, and many of the makers, in order to save freight, send the cars in pieces, and these are loaded so that something approaching the carrying capacity of the wagon is reached.

In regard to the coal cars in use on American railroads, the tendency is to increase the carrying capacity of the present 70-ton cars; in fact, the Pennsylvania Railroad have built and are running a number of coal cars mounted on six-wheeled bogies, with a carrying capacity of 100 tons, and the Pressed Steel Car Company have recently built for the Virginian Railroad a number of steel coal cars having a rated load of 109 tons. These latter cars are 49ft. 6in. long and 10ft. 3in. wide inside, with a depth of 7ft. 4in. at the ends, over the bogies, and 8ft. 6ins. at the middle, the sides and floors being dropped between the bogies to give increased capacity (Fig. 6). The weight empty is 39 tons, of which 21 tons is for the body and 18 tons for the two six-wheeled bogies (Fig. 7). The capacities of the coal cars in general use, however, are from 50 to 70 tons. These cars are built without side doors, but have self-discharging bottom doors (Fig. 8).

The coal tips installed at the Greenwich Wharves, Pennsylvania Railroad, Philadelphia, are arranged so that the coal is discharged from the 70-ton vehicles direct into the bunkers of the vessels. The cars run on to the coal hoist, are lifted up and turned sideways through 90 deg., thus discharging the whole of the contents over the side of the car into a coal chute which extends into the hold or bunker of the vessel. At the discharge end of the coal chute is fixed a trimmer, which consists of an endless belt, power driven, on to which the coal falls. By turning the chute the coal can be shot into any corner of the hold, and thus a great deal of hand labour is eliminated. The car, having been discharged, is returned to the track and is run by gravity on to

a rising gradient provided with automatic points or switch gear, so that when it reaches the end of the gradient it is switched on to another line and its own momentum carries it back into the empty sidings. The coal chute trimming device is capable of throwing the coal a distance of 30ft. The dumper handles from 38 to 62 cars an hour, and, all round, including the time of moving the ships, it handles 1,000 tons of coal per hour.

Owing to the severe weather experienced, it has been found necessary to erect a thawing shed, which is built of ferro-concrete and is fitted inside with nests of steam pipes; this is brought into use in the winter months, when the coal is frozen solid in the cars, and would interfere with the tipping arrangements.

The fact that in America use of the central buffer is universal really controls the design of the cars. On American vehicles the whole of the buffing and drawbar pull is taken on the centre members of the underframe, which are usually in the form of fish-bellied girders (see Fig. 2). The sides of the car are carried on cantilevers attached to these central members, but there is an absence of the solebars, which are prominent in British design. This form of construction tends to reduce the weight of the underframe, and for central buffing it is in every way the most satisfactory. It is hardly necessary to point out that on British vehicles the buffing stresses are taken on the side members, and consequently such a design would be quite unsuitable. To illustrate this point Fig. 9 shows the underframe of a 30-ton bogie wagon recently built at Derby, and from this it will be seen that it is not possible to confine the main strength of the wagon to the centre members. The two solebars and the two longitudinal members in the centre are of the same section, and this is rendered necessary because the drawbar pull and the buffing stresses are taken chiefly on the solebars, although part of this load is distributed also on to the centre longitudinal members.

As to the finish and style of the American rolling stock, it is generally inferior to that of the British railways. To a visitor from this country it appears at first sight that the locomotives, the carriages and the wagons are very rough and unfinished compared with the productions of the railways over here. The American does not seem to take any pride in the appearance of his rolling stock, and never makes any attempt to round off the corners or finish off his work neatly. It may be that in this country we do more in the way of keeping our stock in a smart condition than is really neces-

sary, but, personally, the Author would not like to see the American standard adopted for the rolling stock generally on the home railways. Their repairing methods are in many cases slipshod, and as the vehicles get older their appearance becomes very shabby.

Repairs.

The standardisation, both in general design and of all parts likely to require repair, is very complete, and this is mainly due to the activities of the Master Car Builders' Association, which is not only responsible for all alterations in designs but also deals with the regulations for such questions as the responsibility for damage and repairs, and in many ways conducts business on similar lines to what is done by the Railway Clearing House on this side. The result of the railways coming under the railway administration during the war is that all the freight stock has been pooled, and there does not appear to be the difficulty in carrying out repairs to foreign vehicles (which may be repaired 3,000 miles from their home dépôt) that is experienced in this country, principally on account of the standardisation referred to. One hears, of course, of certain railroads complaining that their stock, which is better maintained than some of the others, is held up on other roads.

There is a number of privately owned wagons in the States, but not anything like the number we have here. These vehicles have to be built in accordance with the M.C.B. specification, and the practice in regard to the repair of these is different from that obtaining in this country, in so far as the railway companies in America undertake the repair of any vehicle which may become crippled on their line. Generally speaking, the cars are very much rougher when first built than those used in this country; they are, however, substantially built, and possibly a mean between the rough American finish and what is sometimes too good a finish on freight stock in this country would be a desirable compromise.

Owing to the cars being built of steel, the equipment at the repairing dépôts varies considerably from what one finds on English railways; more machinery is installed, such as shears for cutting up steel plates; air compressors and pneumatic rivetters; acetylene welding plants, and fires or furnaces for straightening distorted steel members. Very few wheel turning lathes are required, because practically the whole of the freight car stock is running on chilled cast iron wheels.

Passenger Stock.

The standard American passenger car is of the vestibule type, having entrances at the ends only (Fig. 10). All modern coaching stock is of steel construction throughout. The coaches are built with double sides and roofs, and insulation against heat and sound is provided between these two skins by means of felt packing. The floors of the cars are double, with felt insulation, and the top surface is covered with a fireproof cement, similar to that which is used in the lavatories on some of the Midland carriages. The interior of most of the cars is lined with sheet steel, which is enamelled to represent wood panelling, and it is extremely well done—so much so that it is almost indistinguishable from Spanish mahogany finish.

All the modern cars are electrically lighted, and many of the old gas-lighted cars are being converted. The dynamos and equipment are much larger and consequently more expensive than used in this country; the reason for this is that the cars are much better lighted, very often with indirect lighting which requires more current, and, further, nearly all the cars are fitted with electric fans, so that although gas-filled lamps are largely used, the load on the dynamos and batteries is very heavy.

The cars are steam heated, and the pipes are designed to maintain a temperature of 75 deg. in cold weather, which would be too warm for the British public.

Seating is provided for two passengers on either side of the centre corridor, and there are no partitions. Toilet arrangements and drinking water are provided at both ends of the car, and, without exception, the trains are vestibuled throughout. The seats are reversible—somewhat similar to those used on the tops of tramcars in this country, but they are upholstered and not uncomfortable for short distances, although the backs are low and therefore provide no head-rest. When one buys an ordinary railway ticket it entitles one to travel in this class of vehicle only.

Nominally there is only one class of vehicle, but on trains which are running more than 50 miles chair and dining cars are usually provided and, on the night trains, sleeping cars. With the exception of one or two lines, such as the Pennsylvania and New York Central Railroads, all the special stock is owned and operated by the Pullman Company, and a charge, in addition to the cost of the railway ticket, is made on all lines for passengers using the special accommodation. It is necessary to reserve beforehand

accommodation in these types of vehicles. All those who can afford to do so travel in these special carriages.

The chair cars are similar in construction to the day coaches already described, except that the floors are carpeted; they are rather better finished inside and they are provided with one swivelling armchair on either side of the gangway. These chairs are very comfortable and are much appreciated on the long journeys.

Many of the main line trains are composed solely of these Pullman chair cars, dining cars and sleeping cars. Therefore unless the passenger is willing to pay the additional charges for travelling on these "limited" trains and the special accommodation provided, he has to travel by the slower ordinary trains.

The sleeping cars are much more widely used in America than in this country—principally on account of the greater distances. The cars are convertible into day coaches as required (Fig. 11), and are arranged with the beds running longitudinally in two tiers. The bottom berth is formed by pulling out the seats, which are arranged in the same way as those in the day coaches, whilst the upper berth when not in use is folded up against the roof (Fig. 12). Sheet metal partitions are fitted at the ends of the berths, and curtains are hung to screen the occupants from passers-by in the centre corridor. One end of the coach is fitted with a dressing room and lavatory for women passengers, and the other end is provided with a small smoking room in which there are three wash basins and a toilet for the men passengers.

The dining cars are only occupied while meals are being served, and are available for any person on the train. The meals are all *a la carte*, are well cooked and served, and the charges are rather less than those of the hotels. All the cooking is done with a coal fire. On long distance trains the tables and chairs are loose (Fig. 13); these are piled up in the dining car compartment at night, and the dining car staff sleep in this compartment on camp beds.

The modern steel cars in America vary from 50 to 80 tons in weight. Even with the very much larger locomotives in the United States difficulty is experienced in handling a long train composed of these vehicles, and this is particularly noticeable in stopping and starting, when the passengers suffer a great deal of discomfort, especially in the sleeping cars on night travelling. In many cases the weight of the train is approximately 1,000 tons.

I think I may venture to say that the signalling and safety devices are not in any way in such a forward state as those in this country, and therefore their passenger cars are constructed very strongly and are designed to resist the effects of collisions, which frequently happen. Figs. 14 and 15 show the effects of a collision which occurred between two passenger trains, and it will be seen that, due chiefly to the very heavy end construction, the cars have suffered very lightly. In comparison with this Fig. 16, photograph taken after the Wellingboro' accident on the Midland Railway, illustrates the effects of a collision on the wooden construction general in this country.

The question may arise as to why, in view of these pictures, the steel car has not been adopted on the British railways as in America, but there are several reasons why this is not so. In the first place it has been previously pointed out that the steel car as constructed in the United States is extremely heavy, and if one of our dining cars—which is the heaviest passenger vehicle on the Midland Railway and weighs nearly 40 tons—were constructed of steel and to American standards it would weigh nearly 80 tons. A train composed of such vehicles would impose a load on the locomotive which would be much too great for such locomotives as can be built to-day, having regard to the limitations on the axle load and the construction gauge on the British railways. It will also be remembered that the passenger cars in America are entirely of the vestibule type—that is, with end doors only. This is particularly favourable to the construction of steel cars, as the designer is able to make use of the side of the car to form a girder to assist in carrying the load (Fig. 17); in British practice the body of the car is not designed to assist in carrying the weight of the vehicle—this is distributed over the steel under-frame, which is a separate unit in our construction. If the British practice were adhered to in steel car construction—the provision of side doors and the retention of the compartment system—the weight of the vehicle would be increased proportionately very much beyond the American figures.

Further, the policy adopted by the British railways of perfecting their signalling arrangements and thus preventing accidents to trains is surely more desirable than making collision-proof their carriages and hauling additional weight incurred by this policy, particularly when fuel is so very expensive.

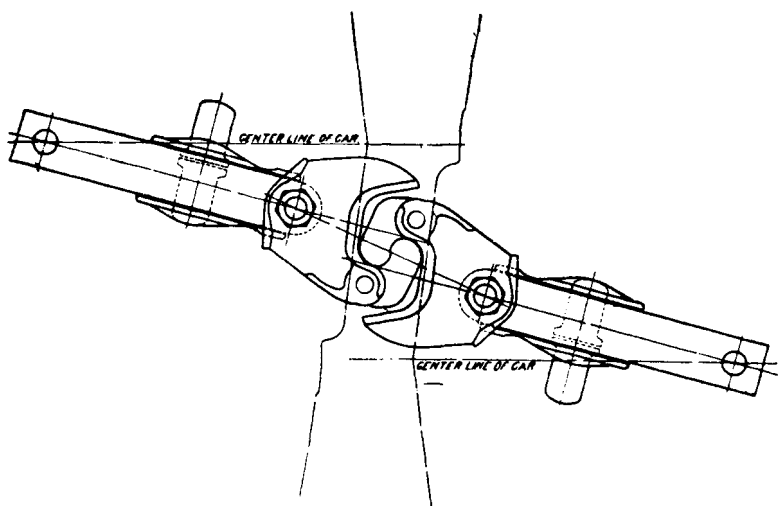


FIG. 1.

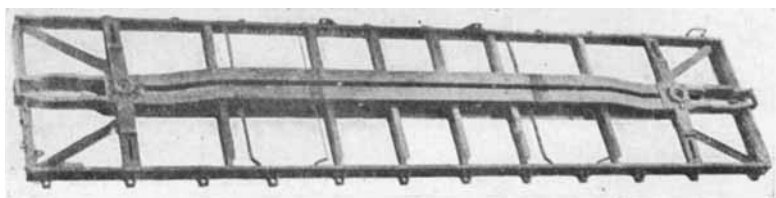


FIG. 2.

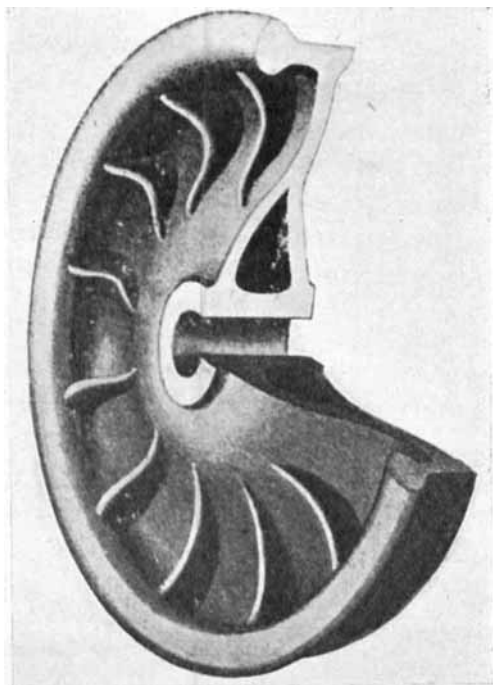


FIG. 3.

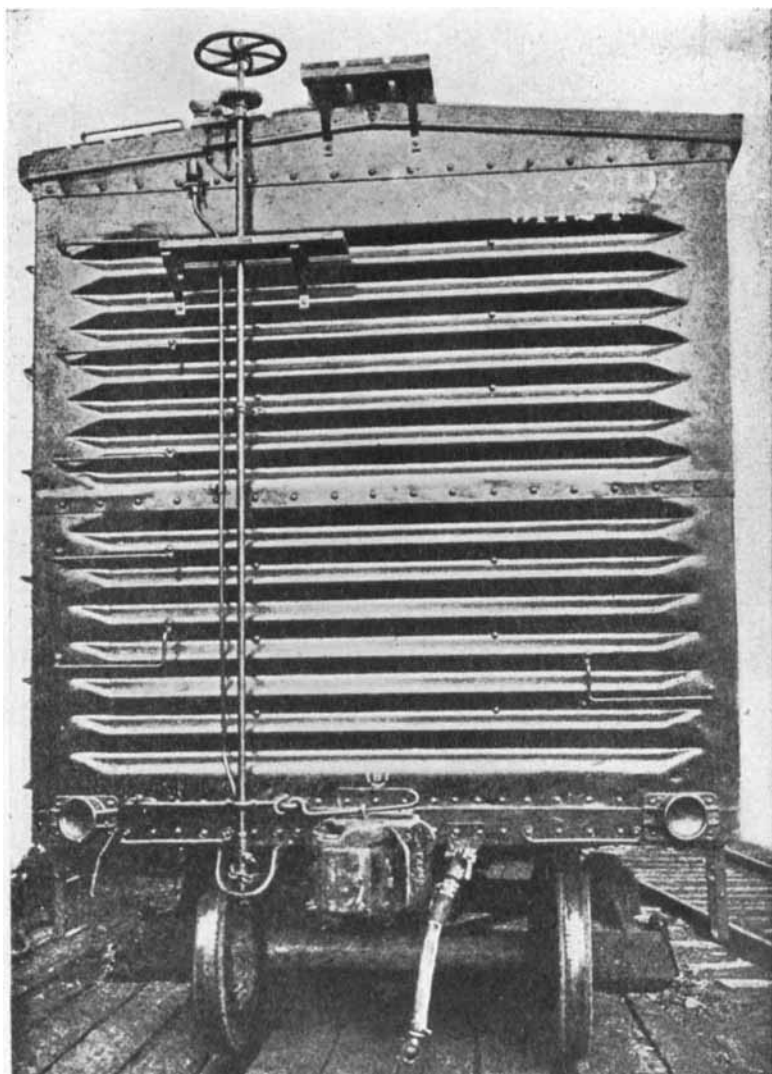


FIG. 4.

FIG. 5.

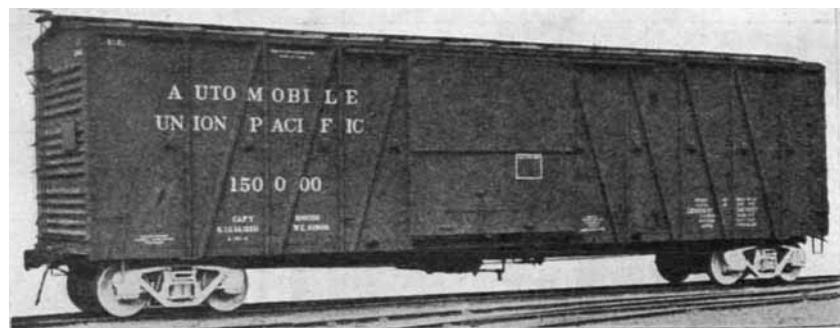


FIG. 8.

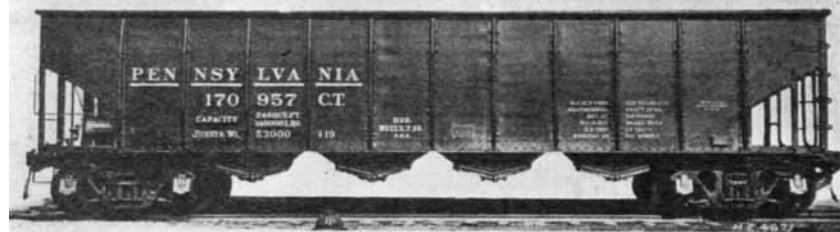


FIG. 10.

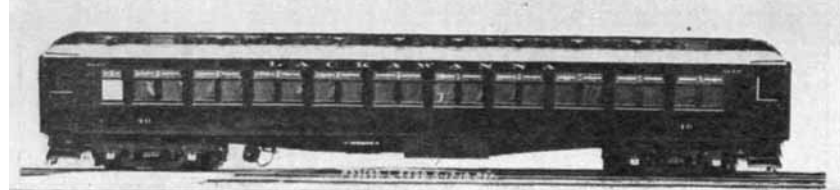




FIG. 6.

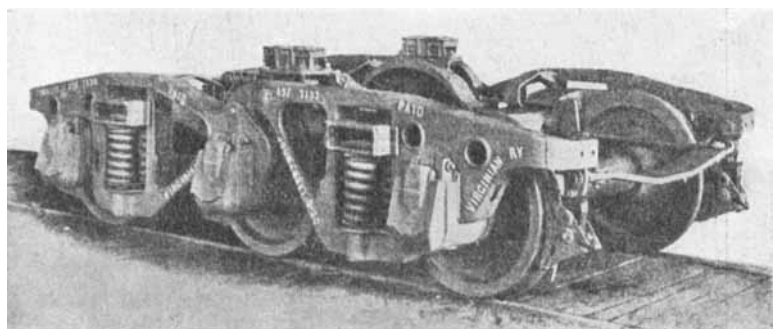


FIG. 7.

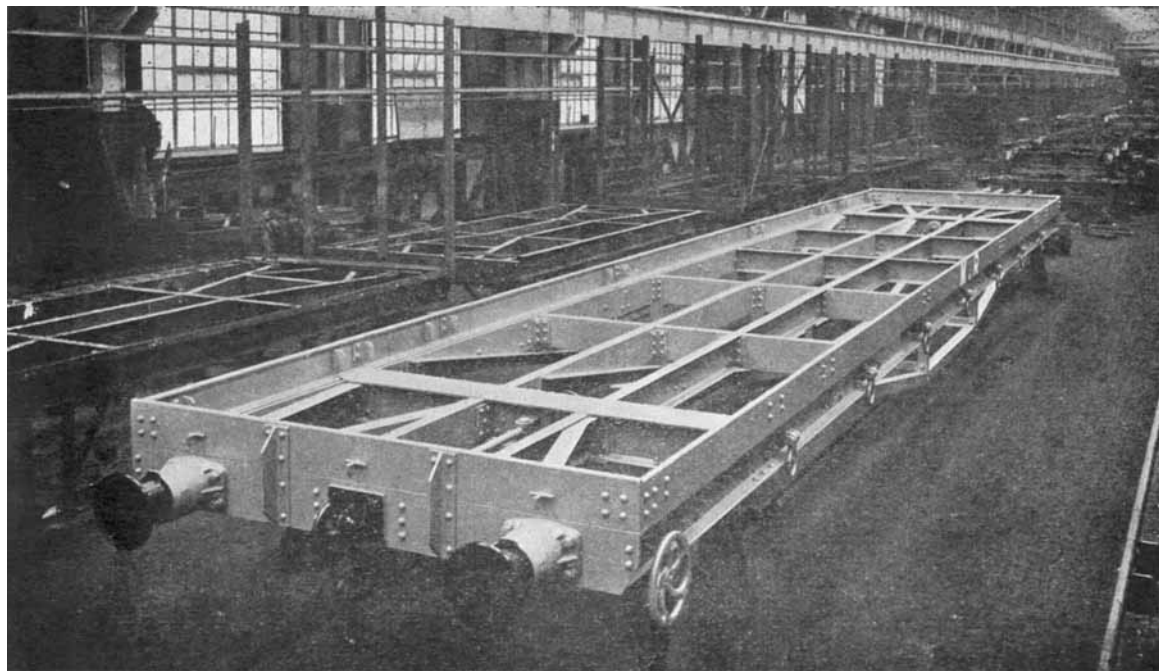


FIG. 9.

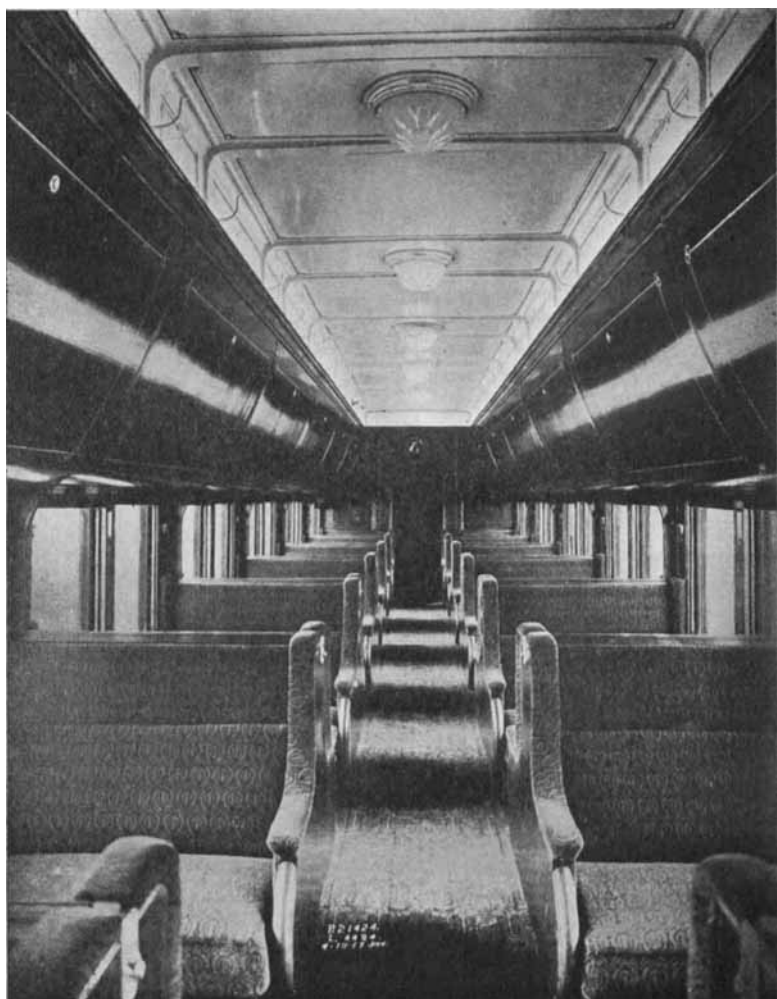


FIG. 11.

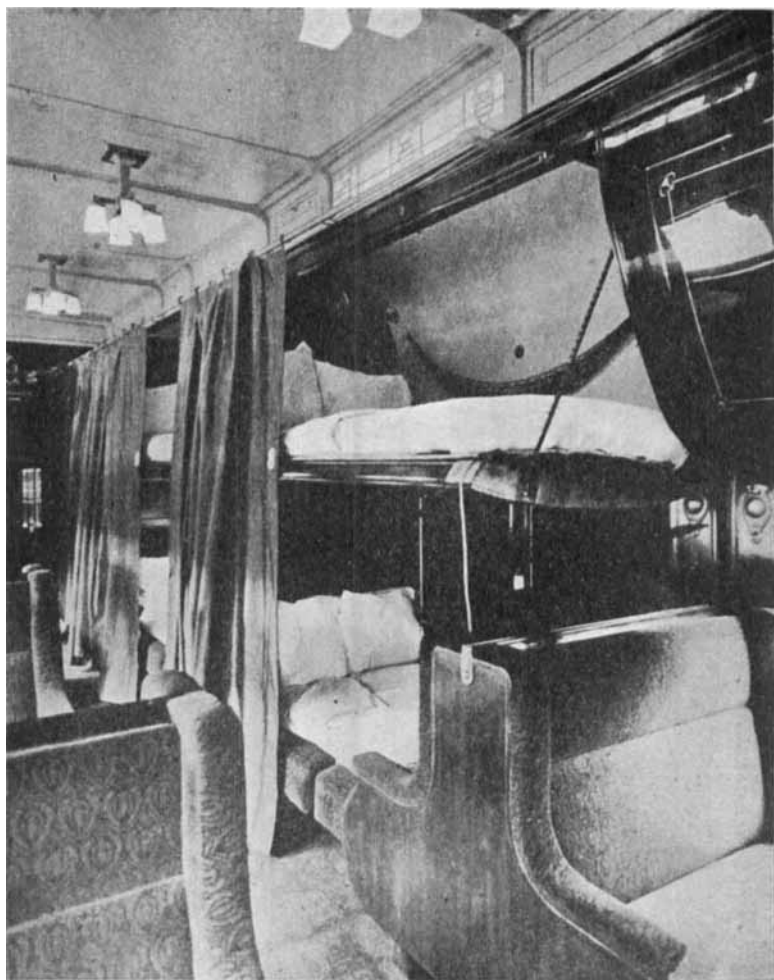
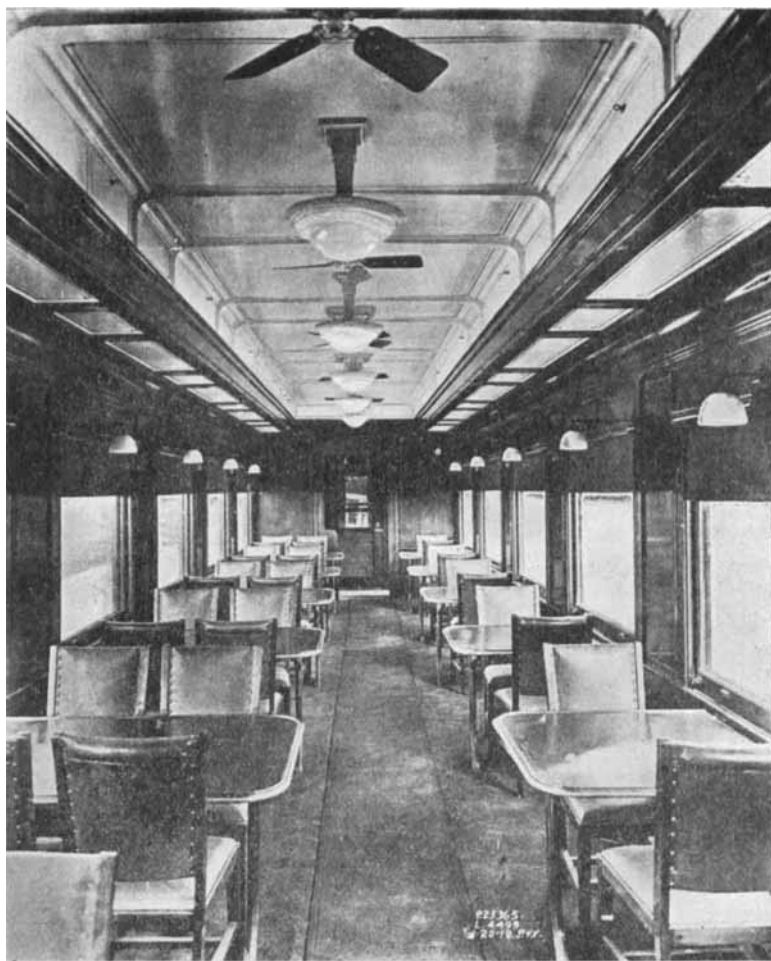


FIG. 12.



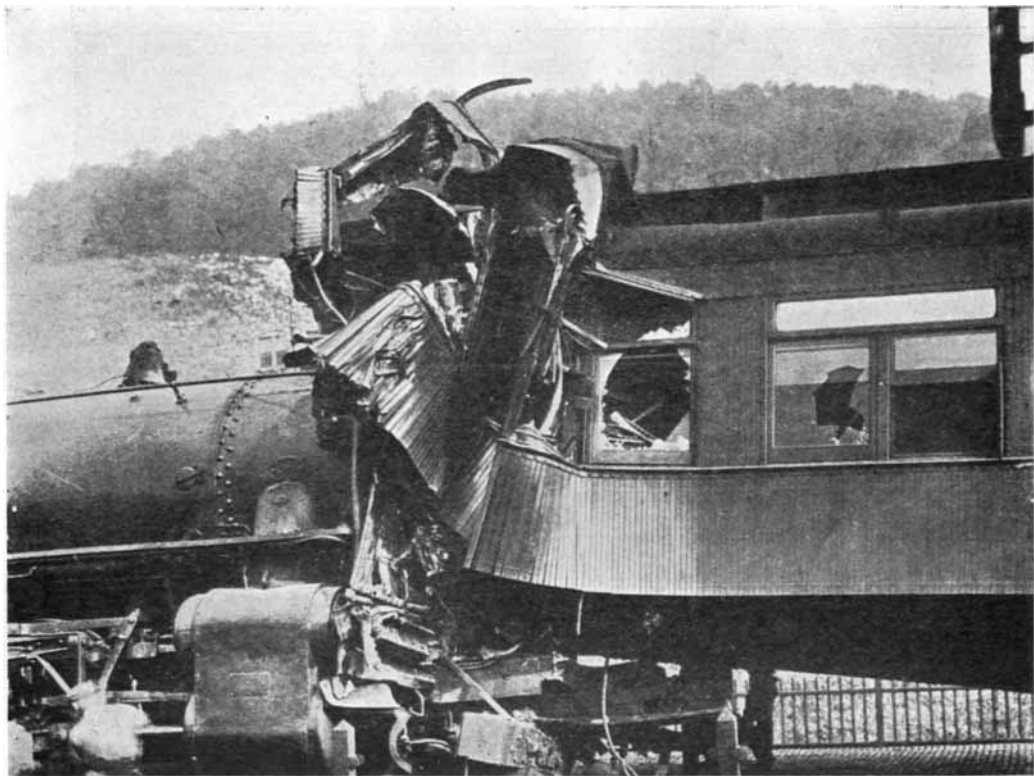


FIG. 14.

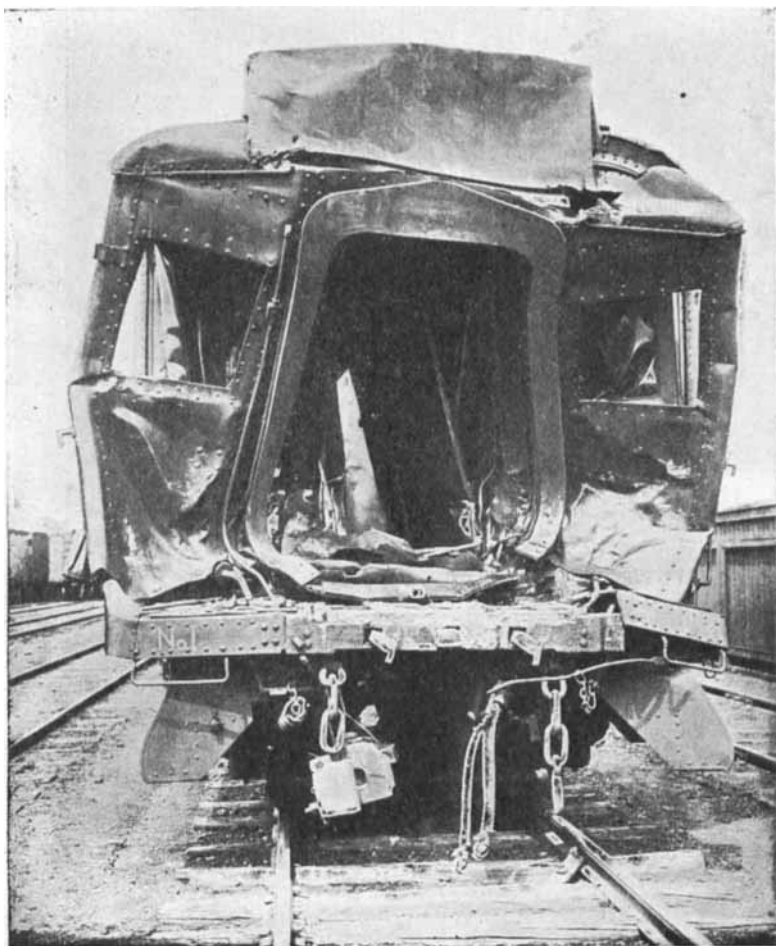


FIG. 15.

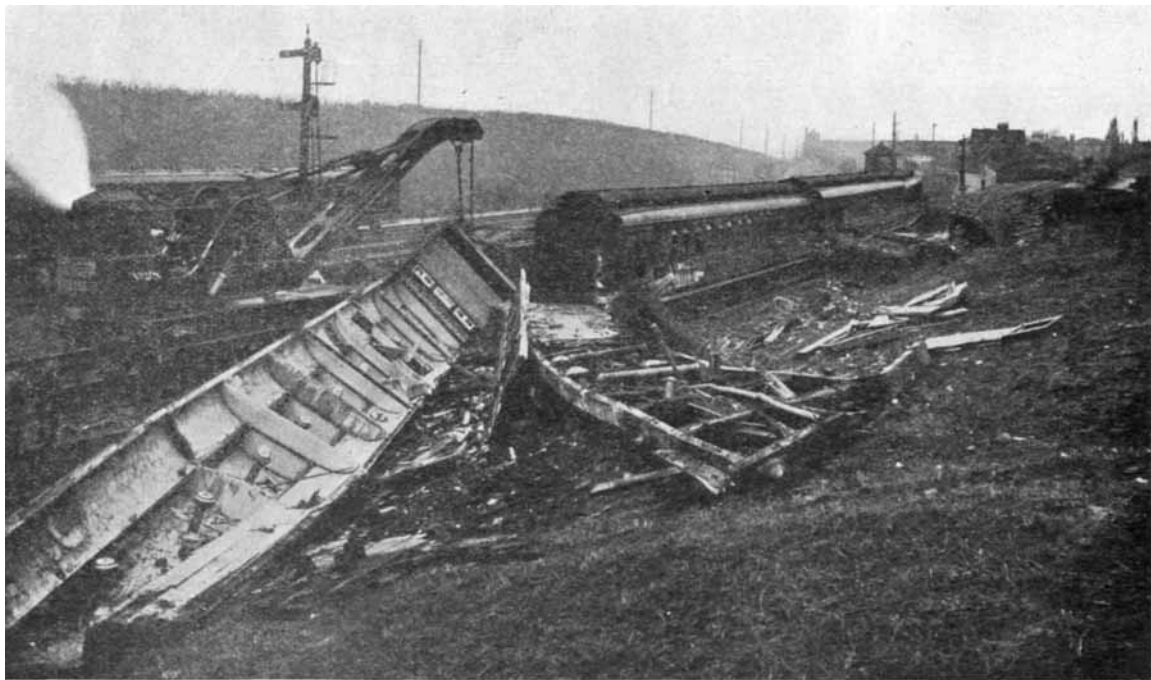


FIG. 16.

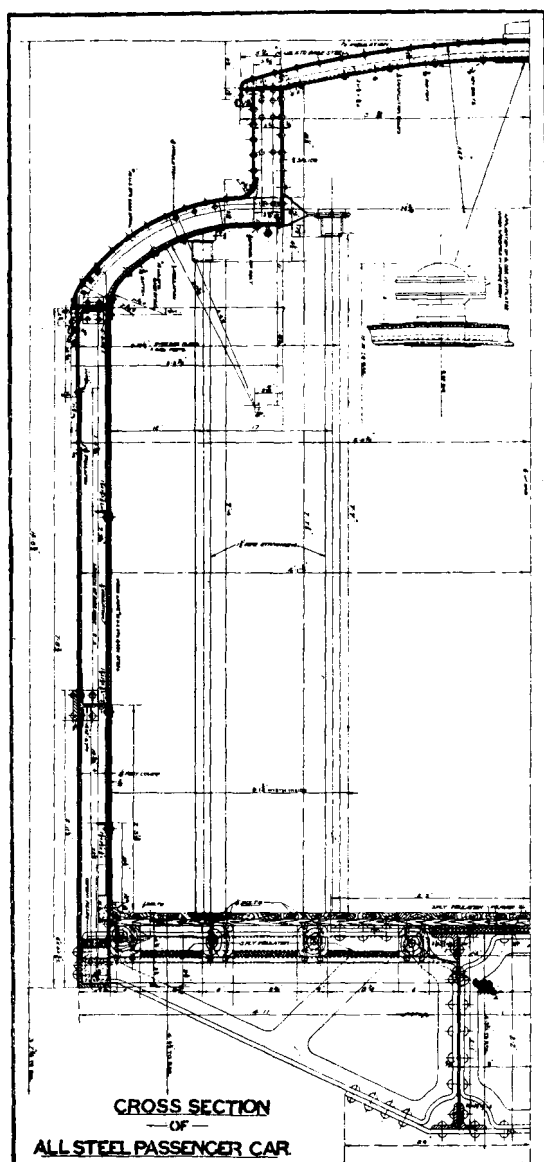


FIG. 17.

DISCUSSION.

The Chairman: I think you will agree with me that we have had a most interesting and instructive discourse by Mr. Reid, and I now have much pleasure in asking any of you who would like to do so to enter into the discussion. From my own point of view a very prevalent idea seems to be that, if you want to see anything new, you have got to go to the States to see it. As the Author has said, I think there are a great many matters of detail that we could take up and adopt with advantage; but, as a general principle, if we had to meet the same conditions over here, I think we should very promptly be able to comply with them. You heard Mr. Reid state that a good many of the American methods are somewhat slipshod. Well, we in this country may be a bit hide bound, but I would much rather prefer to see a reasonably well finished job than a slipshod one. Mr. Reid advocates a happy medium, and I think that that is perhaps the best course to pursue. I quite agree with the Author that it is a better thing to see to the perfecting and the safe working of your railway rather than to build what might be called armoured vehicles to cope with some possible collision or other accident. There were one or two questions I meant to ask Mr. Reid, and one was with regard to the use of the cast steel wheel. I am not sure whether the use of that is extended to the coaching as well as the wagon stock. Another point was, he stated how very heavy their steel carriages seemed to be. Can the Author tell us the particular gauge of the general plating in these vehicles of steel construction? It occurs to me, although I have not had much experience in the matter, that one might be troubled with internal corrosion at the points where the thin panelling is attached to the stronger parts, and this would perhaps be rather a difficulty because of the inaccessibility of the point at which the corrosion was taking place; and it seems to me, with the big weights that Mr. Reid spoke of, that very probably the American practice is to use very much heavier plating in addition to the scantling. I was wondering, too, as to how they deal with any breakdown in their wagon or carriage stock, but more especially their wagon stock, at far distant points, because, with the exceedingly heavy weights they have to deal with, it might be that the ordinary appliances would not be of much use, and that, unless they had some adequate lifting arrangement, a vehicle would probably be detained a considerable time, or have to be rigged up and sent a very long distance for repairs.

Another point is, we in this country have of late been talking a good deal about the use of automatic brakes on goods trains. I rather fear that in putting such into practice in this country we might expect a good deal of trouble in the working of the brake, consequent on irregular loads, and the composition of trains and so forth, and I would like to ask Mr. Reid whether the Westinghouse brake as applied to goods stock works satisfactorily. I do not know that I have any other points to raise, but perhaps some others would like to make a few observations on the Paper.

Mr. Irvine Kempt (Caledonian Rly., Glasgow): With regard to the higher capacity wagons which they use in America, I think it is generally accepted that for long distances higher capacity wagons are the most suitable. Of course in America they have large transshipment stations where the small loads are transhipped into wagons until fully loaded and then travel up to, say, a couple of thousand miles. In this country, however, the distances are not great enough to make it worth while having such transshipping arrangements, and the smaller wagons can be run more cheaply to the places they are loaded for.

As regards the sleeping accommodation on the American cars, Mr. Reid has pointed out that an open saloon has double berth arrangement on each side, that is, one passenger above and one below. That I do not think is pleasant, and I much prefer the British type of sleeping car, either the Midland or the West Coast sleeping car. Besides want of privacy this double berth arrangement on the American car is somewhat disagreeable to the occupants of the lower berths when there are strange people climbing up to the top berth.

The lavatory accommodation is not quite as good as one would like, and one has to go along the centre of the car to reach it.

When in Chicago I visited the Pullman Company's works, but was very much disappointed with them after what I had heard and read about American practice. It struck me then that at St. Rollox we were very much ahead of the Pullman people. The whole place seemed to be very untidy, while a plentiful supply of shavings littered the floor. The smithy and the forge were nothing like what we had here at that time. From what Mr. Reid has stated, however, considerable progress appears to have been made in the Company's works since then.

Mr. Walter Chalmers: It was not my intention to say

anything on the Paper, but I am rather interested in steel car construction, and Mr. Reid has told us quite a lot of things about that and other matters affecting American railroad practice. I have in use six experimental steel cars, not entirely of steel, but having complete steel underframe and body externally; the only timber being a small amount for decorative purposes, and, like you, I am rather concerned to know what is the practice and experience of the Americans after the side sheets have been in use for a number of years. There is the problem of keeping down noise, which the Author refers to, and which appears to be overcome by careful building and the use of some felt or other material interposed between the inner and outer skins. But I am not quite sure whether these things are successful, my experience only going back over a year or two. Another point regarding which I would be glad to hear Mr. Reid's opinion is whether the rivets remain tight in these very thin sheets. Another difficulty which appears to me very likely, particularly in the case of the dining car, is in connection with the kitchen, which is probably greater in capacity on the American than on our British railways. From this kitchen there comes steam and hot air into the compartments, and it has been my experience that in cold weather there is a lot of sweating on the inside of the coach. Perhaps the Author could give some enlightenment on these points.

The Author: The Chairman inquired as to the wheels used on passenger stock. A rolled steel wheel like the Schoen wheel is used. These wheels are not re-tyred, but when new a scrapping line is turned on the face of the tyre, and, as soon as the tyre is worn down to that line, the wheel is pulled off the axle and sent back as scrap to the steel works. All heavy coal wagons have rolled steel wheels.

Steel panels vary from $\frac{1}{4}$ in. to about $\frac{1}{16}$ in. Roof sheets are about $\frac{1}{16}$ in., and the panels up to just below the lights are made of about $\frac{1}{4}$ in. steel. The whole design of the car is such that there are no joints exposed for leakage. The windows of American cars, instead of opening downwards, open upwards, so that there are no pockets where the water can lodge, and the roof sheets, which are most liable to corrode, are made of a steel with quarter per cent. of copper in it, which is said to give a certain immunity from corrosion, although I have seen many of their sheets corroded, but these have been on cars running over 15 years. The car panelling is riveted with $\frac{5}{16}$ in. or $\frac{3}{8}$ in. snap-headed rivets, and the joints between the panels and the framing are

all closed by electric welding. Then the steel car goes into a sand blasting shed, where the whole car is sand blasted inside and outside. When it comes out it has that grey colour that one sees on a fractured piece of steel, and the mill scale is cut right out of the panels. The car is then ready for painting. The subject of painting is most important on steel cars. The paint is fed under a small pressure to a T-shaped perforated pipe which literally runs the paint down the car. Then the whole car is pushed into a very large oven and baked; next day it is taken out and rubbed down, and the process is repeated for three or four coats. The finish is very like a bicycle enamel finish, and stands as well.

Then the Chairman asked about breakdowns of wagon stock at far distant points. The only breakdown that gives any trouble is a bogie breakdown, but it is made much easier by the frame being in one piece. All the bigger depôts have a pit, and, when changing wheels, the truck is run over this pit, which has a platform like a small hydraulic hoist, so as to drop the wheels for changing.

A train may not be coupled unless 40 per cent. of the vehicles are braked, and the staff seem to get along all right with that. The maintenance of the brakes is quite a big affair in America.

Mr. Kempt spoke about transshipping stations. Of course the American people are very much more arbitrary than we are in refusing to accept small quantities. Preference is given in rates for bigger loads. The freight is quoted per car load, so that higher rates are charged for less quantities.

With regard to Mr. Chalmers' remarks, I think I have already replied to the points which he raised about corrosion. As to sweating, I think one is bound to get that. There was some trouble with the floors in the dining cars when the cement cracked, allowing water and so forth to get to the steel floor; otherwise, I think it is a very good job.

The Chairman: I think I express the sentiments of all when I say that we have had a very interesting lecture and discussion this evening, and I would now ask you to accord Mr. Reid a very hearty vote of thanks for his Paper and for his kindness in coming here to-night.

The vote of thanks was most cordially given, for which the Author expressed his thanks.