parts, so that another car has had to be sent out to collect the fragments and bring the vehicle back to the depot.

In country districts, however, the case is different. Distances are much greater and the service very much less frequent, so that it is necessary to employ men who are capable of doing small jobs on the road themselves, and also to telephone correct information respecting any breakdown with which they are unable to cope. The author has himself received a message from the driver of a car twelve miles from the base, saying that it was completely broken down, and asking that another might be sent out to fetch the passengers and tow the 'bus home. On arrival it was found that the 'bus had been ascending a steep hill, and that the clutch had been slipping, a defect that was remedied almost immediately. Where only two or three cars are worked in all, it will be found best to employ only competent mechanics, who are capable of keeping their cars in order unaided, and will be responsible for their condition.

The aim, therefore, of the young man starting as a driver for a large company should be promotion to the most difficult route operated by that company, and thence to country service, where more and more technical experience is required, until ultimately he becomes responsible for his own car. It is probable that eventually large companies will draw their drivers in the same manner as do the railways, from the ranks of cleaners, who have started with them as boys; in fact, some of the larger companies are working as far as possible on that system to-day.

Before leaving the question of drivers, one cannot help referring to the large number of vans working in different parts of the world, driven almost without exception by the men who had previously driven the owner's horsed vehicles, with marked success. This

large body of men has been brought to the work direct from the horses, with not more than one—at the outside two—weeks' training. In this connection the system of training men adopted by the Paris Omnibus Company is of interest. It was the author's privilege to see all over the works of that concern towards the close of 1906. Horse 'bus drivers are selected and taken for training in batches of thirty, ten going to each training 'bus. After a short lecture, they are gradually taught to steer and then drive on the private roads inside the company's works. They are next taken over quiet roads in the neighbourhood of Montmartre, and ultimately taken to the Prefecture of Police, where they are examined and licensed. Even then the company does not leave them unattended, but puts them with the best drivers, who first let them drive over the easiest sections of the route and only at last over the city sections. When they are ultimately placed in charge of their own vehicle they are distributed as widely apart as possible, in order that no dislocation of the service may ensue.

Depreciation and Maintenance Costs.—Some may wonder why these two items are classed under one heading. It is simply because it has been found in practice almost impossible to separate them, the one being so dependent on the other. It is obvious that the state of repair in which the vehicles are maintained must influence very largely the sum set aside each year for depreciation. Taking the 3-ton chassis as typical, it can be made to cost anything between $\frac{3}{4}$d. and $2\frac{1}{4}$d. per mile, according to the age of the vehicle and the general state of repair in which it is kept. Thus it will be seen that, except for a certain necessary provision for what may be termed antiquation, the two items are inseparable.

In motor omnibus work the subject has been discussed again and again, largely on account of a desire

to establish the real financial position of certain companies. In 1904, when the first cars appeared, those who had experience in the working of heavy motors demanded an annual allowance of 20-25 per cent., while others regarded 12-15 per cent. as sufficient. Of about the first 30 vehicles put to public service in London not more than three still remain at that work, although a number of them are employed in the country and on mail services; 25 per cent. for these cars does not appear, therefore, to be excessive, although it must be remembered that some of them were purely experimental. The remaining three are now entering on their sixth year of service, and there is every reason to believe that they will prove equal to another five years' service, and the same may be said of those other models which succeeded them and proved successful.

It is quite impossible to determine from observation the life of a modern omnibus, as before the vehicle has been in service twelve months the frame, axles, and springs are probably all that remain of the original car, it being now the practice to replace any parts, such as the engine, radiator, gear-box, etc., that need repair on the road, if need be, and to do the work at leisure during the day, the repaired part being drafted into stock in due course. As a general rule an allowance of 15-16 per cent. is ample, as the main parts of the cars are well able to stand it, and others are best dealt with under maintenance. Another excellent plan is to deduct 25 per cent. the first year and to continue deducting the same percentage year by year, not of the original cost, but of what remains each year, which always leaves something at the end and can easily be made to represent scrap iron and the one or two parts that can be used a second time.

Working Costs.—In a series of tables appended will be found a number of diagrams dealing largely with the

working costs of heavy motor cars. Table 1 is devoted to those of motor omnibuses in Eastbourne and London. The former have been chosen, as they include some old machines which were originally new about 1900, when the service was started. Many attempts were previously made to get a service of trams at a capital cost of £30,000 for seven cars. The Corporation now owns 16 motor omnibuses, at a capital expenditure of £11,000, and (for the first time) in 1908 had a genuine surplus in hand. It will be noticed how the cost went up by 2½d. per car mile between 1905 and 1906. This is partly accounted for by a mixed fleet and the greater attention paid to the repair of the older types of car.

The two columns devoted to London give actual figures for 1906, and for a small company owning 16 cars, which are maintained under contract by the makers, which is included to show what can be done by a small concern when it sets itself to it. Current figures for the large London General Omnibus Company work out between 8d. and 8½d. per car mile as against 10½d. to 11d. three years ago—a great saving.

Table 2 has been prepared to show the range of actual cost per mile and per ton mile of all kinds of mechanical and dirigible road vehicles from the traction engine which travels at from 3-4 miles per hour to the light van travelling at 18-20 miles per hour. It also shows very clearly what has to be paid for speed, showing as it does that the light van costs 4.3d. per ton mile more to the run than the traction engine. In the same connection it must be remembered that mechanical traction of all kinds shows a distinct saving over horses, but it is from heavier loads that the greatest saving is effected.

Table 3 shows in the form of curves the history of London's motor 'buses. Those for 1905 and 1906 show steady increases, whilst 1907 shows two great drops, due

to the withdrawal of two operating companies and to the failure of the steam 'buses. 1908, again, shows a steady increase until nearly the close of the year. It should be here explained that these curves are the property of the "Commercial Motor," and until the autumn of 1908 were prepared week by week by the author, but at this time it was agreed by the authorities to supply each month the actual number of 'buses in commission at the time of supplying particulars. It will therefore be realised that the curve from October, 1908, to date is quite accurate, and shows steady decline in the number of cars in commission from 1097 in October to 926 in March, 1909, from which date it steadily increased to 1075 on July 1st. This is due to the new system of maintenance inaugurated last year, whereby overhauling and painting is done in the winter months, so that all available cars may be in service during the summer. The companies have realised that motor 'buses actually cost money when they are running, whilst horses cost nearly as much to keep idle as to work, so that services are now curtailed during the winter months and every available car put in service during the summer.

The same thing applies with equal truth to motor haulage, and firms desiring to apply motors to their business can only do so successfully by keeping waste or empty mileage at the lowest possible figure.

Conclusion.—In the course of the present paper it has been the aim of the author to put forward some of the many difficulties that have had to be overcome by the engineers responsible for the management of these vehicles. Most have been put on a working basis, especially the driver question, tyre problem, ignition, and maintenance of the cars. The question of cooling the engines is deservedly receiving much attention at present, and will probably end in the abolition of the pump

and fan and the adoption of the thermo-syphon system. Urgent attention is, however, needed on the subject of lubrication. It ought to become efficient enough to warrant the large owners paying something like 4s. per gallon for oil, to the benefit of the engines generally, especially the bearings. Carburation, too, needs particular attention, as the odour from the exhaust makes it obvious that some 30 per cent. further saving under this head should still be possible. The clutch, gear-box, and final drive need consideration together, but in view of the urgency of those problems just mentioned, and the great improvement effected recently in gears, this can safely be left for the moment; but with the lapse of the Hall patents and the erection of manufacturing plant by some big users, it is probable that some form of hydraulic gear will be adopted.

With regard to goods haulage, mention must be made of the great trials of 1907, which showed conclusively that for loads up to three tons petrol must be regarded as the more economical source of power, for loads from three to five tons either petrol or steam might be used, but that above that weight steam was the only suitable power. Since then petrol has advanced, until one must admit that for higher speeds with five tons petrol must be regarded as the correct method.

But what about the future? one naturally asks. Is steam or petrol going to remain—or both? And then what about electricity? Taking the last one first. If anyone can invent wireless means of collecting unlimited supplies of current from the air or produce a storage battery that shall be light, be capable of running its car 150 to 200 miles without recharging, and can then be charged in a few minutes, then the future is undoubtedly with electricity—otherwise it isn't.

Regarding steam next, it is necessary to refer again to the utter failure of the steam 'buses wherever

tried, including Sydney. Whereas the steam lorry obtained its steam either from a horizontal loco. type of boiler or from a vertical centre-fired type, this was not considered possible, which indeed it wasn't, for faster work where speeds of twelve miles an hour had to be attained and stopping and starting was frequent. Recourse was therefore had to flash or semi-flash boilers, working up to 800 lbs. per square inch, and there the trouble began. It has been variously attributed to the pump, boiler plates, and tubes, but possibly the working pressure was more to blame. The author has frequently watched the pressure gauge on one of these cars standing at the bottom of a hill at 850 lbs. steadily drop during the ascent to 100, when a stop would have to be made while the pressure rose again. The strain on the pump on such occasions must have been enormous, and when it failed through any cause and the hand pump had to be brought into play, cold water was being pumped on to red hot tubes, with ultimate results that can be well imagined! The modern type works only at 250 lbs., and two mechanical pumps are provided, which seems to be very satisfactory. All the same, the future for steam lies with slow speed, steady work—although the author feels that petrol will eventually be more and more used, notwithstanding the fact that the steam car will always be cheaper to buy in the first place.

Lastly, the petrol engine. It has been much abused by almost everybody, but few who haven't an intimate knowledge of it can realise the use and convenience of it. It must be remembered, too, that it was petrol that first made the motor car of to-day a success, and that has brought it to its present unassailable position. With the abolition of those bugbears of the motor engineer—the clutch and gear-box—and further economies in maintenance and fuel, the future of the petrol engine for road haulage is bright enough to please its most enthusiastic supporter.

TABLE I.

Analysis of Working Costs of Motor Omnibuses, Eastbourne Corporation, London.

	1905.	1906.	1907.	1908.	1906.	May '09
Mileage	92,514	80,484	119,480	190,463	...	...
Expenditure						
Running	6 95	8.6	6.78	5.26	5.312	5.040
Repairs						
Maintenance	2.35	2.66	1.3	2.47	1.800	2.400*
Depot	.21	.15	.15	.21	.800	1 000
Management	.26	.36	.41	.66	.400	880
General Exps.	.04	.2	.08	.03	.600	.580
Capital Charges	1.42	1.8	1.97	1.11	1.360	.850
Special Charges	...	...	.28	...	...	...
Totals	11 23	13.77	10.97	9.74	10.272	10.750

*Contract price.

NOTE.—Column 4 has had to be worked out from the balance sheet just published and may not be accurate. Column 6 is actual costs of a small company in London (owning 16 'buses) during May, 1909, and are consequently higher than for a large company, which would work out at a fraction over 8d. per mile.

TABLE II.

Working Costs of Heavy Motor Cars in England.

	per mile.	per ton mile.	Miles per diem
Traction Engine (steel tyres) ...	14.49	1.01	30
Tractor (steel tyres) ...	15.384	1.709	40
Steam Lorry (steel tyres) ...	7.13	1.78	50
Steam Lorry (rubber tyres) ...	8.5	2.12*	60
Petrol Lorry (steel tyres) ...	9.47	3.79	56
Petrol Lorry (rubber tyres) ...	10.5	4.5*	65†
Petrol Van (rubber tyres) ...	8.756	5*	100†
Small Petrol Van (15 cwt.) ...	4.25	5.32	100†

*Estimated. †Upwards.

TABLE III,

COMPARATIVE CHART OF LONDON MOTOR OMNIBUSES IN COMMISSION.