DISCUSSION.

In the discussion following the paper—

Mr. A. J. MURPHY said the figures Mr. Evans had given were most important. He thought that papers ought to be circulated among the members before the meetings. It was not possible to bear in mind the mass of figures that had been given, and consequently it was very difficult to discuss such a paper. He would like to know whether Mr. Evans held the view that the palate fulness depended upon the presence of malto-dextrins to a large extent. Any attempt to throw light on the question of palate fulness, in his opinion, deserved every encouragement. He further asked whether, in calculating the amount of maltose and dextrin, an allowance had been made for the reducing substances (malto-dextrin), consisting of combinations of maltose and dextrin. Mr. Evans appeared to recommend specially prepared sugars for priming, in order to produce palate fulness. No doubt sometimes the addition of sugars for that purpose would be useful, though not absolutely necessary; but taking an all malt grist, it seems possible that by selecting a grist carefully, and adjusting your mashing heat accordingly to produce beers with a very considerable amount of this palate fulness, even without the use of sugars. Would Mr. Evans recommend the universal use of sugars for this purpose rather than the adaptation of a suitable mashing heat, and the selection of a suitable grist?

MEETING HELD ON FRIDAY, 23RD FEBRUARY, 1900, AT
THE QUEEN'S HOTEL, LEEDS.

Mr. C. HAROLD TRINDER in the Chair.

The following paper was read and discussed:—

Motor Traction for Brewers.

By FRED. M. MAYNARD.

Introduction.

DOUBTLESS to many brewers the idea of propelling their drays by steam power is still somewhat of a novelty, and some may even look

upon the innovation with a considerable amount of scepticism and suspicion, but it will be my endeavour to-night to convince you, and all who may read this paper, that there are no grounds whatever for doubting either the practicability, absolute reliability, easy management, and great economy of this new substitute for the horse.

Further, I am quite certain that brewing firms generally, possessing as they do a keen eye for anything conducive to a reduction in working expenses, will not hesitate much longer in following up the lead already set them by such firms as Guinness of Dublin, Bass of Burton, Groves of Weymouth, Fuller of Chiswick, and many others who have thoroughly tested this new form of traction, and have in several instances decided to increase their stud of motor drays. Municipal bodies also, in various parts of the country, have for a long time past, with economical results, adopted motor dust and water carts, whilst the L. and Y. R. Co. is substituting motor lorries for their horse-drawn wagons in the Manchester district.

Historical.—Although the present revival of steam road locomotion only dates back to the passing of the Locomotives on Highways Act in 1896, steam cars and wagons existed in England as early as 1770, about which time Murdoch and Symington constructed the first steam propelled road carriage, but which, under the then existing conditions of the engineering trade, was naturally far from perfect. In 1788 Robert Fourness of Halifax is reported to have built a steam vehicle of considerable merit, though practical automobilism scarcely made a fair start until 1831 or 1832, when a steam coach service was established by Sir Charles Dance between Cheltenham and Gloucester, and Church's ornate steam carriage plied regularly between Birmingham and London. Among other practical motor vehicle constructors contemporaneous with the foregoing may be mentioned Hancock, Maceroni and Squire, and Hill, all of whom seem to have been fairly successful. What however stifled the motor industry in those days was, firstly, the great opposition in Parliament from those interested in the development of the railways, and secondly, the bitter animosity of the agricultural and land owning classes, who looked upon the steam coach as a serious menace to the horse breeding industry and its allied and dependent trades. This fear of the horse being supplanted was also mooted during the early days of the present revival, but steam road vehicles are no

more likely to effect such a result than are the locomotives on our railways.

The development of the motor industry at the present day has unfortunately also been to a serious extent hampered by prejudice, and further by the operations of the company promoter; it is, however, a very significant fact that the most successful systems, especially of the freight-carrying vehicles, are those which are not in the hands of the owners of all automobile "master patents," though doubtless many firms who have embarked on the construction of the lighter passenger carriages were until recently deterred from doing so by the fortunately baseless threats of these capitalists.

The 3-ton Limit.—The law also as it stands renders the construction of that valuable type of motor lorry, calculated to carry safely loads of from 4 to 10 tons, an impossibility, and as it is just this class of auto-wagon that is so urgently needed in Liverpool and the surrounding districts, the sooner the 1896 Act is amended the better. The unsatisfactory portion of the Act referred to is that which limits the tare of a mechanically propelled vehicle to 3 tons; that this is an unnecessary, harmful, and vexatious restriction is clearly proved by the fact that very many horse-drawn vehicles greatly exceed this limit; take a full sized brewer's dray, for example, capable of carrying a load of 14 barrels, this, together with its necessary team of three horses, will actually scale over 4 tons, while the heavy horse lorries with their teams in use in Liverpool will still further greatly exceed this weight.

The idea of fixing this tare limit was presumably to prevent these new light locomotives, which were only supposed to replace horse-drawn vehicles, from developing into machines of the heavy traction-engine type, whereby bridges only intended for light traffic would be imperilled; but as it is perfectly certain that this new form of traction will be found far too valuable to be hampered by such trifling considerations, the most sensible line for our local authorities to adopt will be to strengthen such bridges to accommodate this new form of traffic, providing as it will a means of opening up isolated villages and districts, by bringing them into more rapid communication with the larger centres, thus benefiting the community at large to a degree which it is impossible to over estimate.

Another reason adduced for the 3-ton restriction was that roads

would be seriously cut up by the heavier loads likely to be carried on the more powerfully propelled vehicle. This is, however, an utter fallacy, as there is nothing to be gained, except on uniformly hard roads, by the use of a narrow tyre; as soon as a wheel cuts into the ground the tractive resistance is enormously increased, as is fully appreciated by traction engine makers as well as heavy lorry builders. Experience has shown that tyre width should be regulated to the gross load distributed over the four hubs: thus for a standard 3-ton steam dray, capable of carrying a useful load of $3\frac{1}{2}$ tons, the tyre widths are rear (driving) wheels $5\frac{1}{2}$ inches wide, front (steering) wheels $4\frac{3}{8}$ inches. These tyres, far from being unpleasant or heavy in appearance, match the vehicle perfectly, while permitting of a thoroughly strong wheel calculated to stand rough usage over all descriptions of roads. It will, I think, even be generally admitted that with motor traffic the roads will be very much less injured than by horse wagons, inasmuch as there is an entire absence of that destructive pulverising action due to the horses' hoofs, while the broad smooth tyre of the automobile will actually tend to bind together and generally improve the road surface.

So far as brewers' requirements are concerned the 3-ton tare is not so serious a consideration, as this puts at our disposal a dray fully capable of dealing with our largest loads, while by the employment of a trailer a total capacity of 25 barrels can be secured. It must, however, be most emphatically stated that this 3-ton limit only permits of the construction of a vehicle sufficiently reliable and stable for an actual net load of 3 tons (on the motor wagon), and the specious assurances of some makers that their vehicles will easily carry from 4 to 6 tons must be accepted *cum grano salis*, the Liverpool Trials having conclusively proved that, although such weights may be carried, the life of the vehicle is enormously shortened, and what is of still greater importance the factor of safety is seriously jeopardised.

Speed.—The maximum speed allowed by the Act for these heavy automobiles is five miles an hour, and for heavy traffic on ordinary roads this is generally accepted as satisfying all requirements for the present, although the better class of vehicles as now built are fully capable of maintaining a speed of six miles an hour, without detriment to their stability. It is, however, a fact well recognised by experts that the wear and tear of a steam dray increases very much more rapidly than in simple proportion to the speed, owing to the

jarring effect due to road impact. The maintenance, therefore, of higher speeds would necessitate very much stronger and stiffer construction; but it is exceedingly doubtful whether the increased speed, even if permitted, would be really worth the very greatly increased cost involved. Five miles an hour however being nearly double the average speed at which a team of horses will draw a 15-barrel load, it is clear that mechanical traction already scores very heavily in this direction.

The purposes for which the motor lorry will be found so valuable will be as a rapid and cheap intermediate form of transport over distances too great for the economical employment of the horse, but not of sufficient length to warrant the indirect delivery by rail, necessitating as the latter does cartage to a railway depôt, very often transshipment in transit and horse delivery at the end of the rail journey. Brewers know only too well that with railway-carried orders complaints of leakages and so forth are of frequent occurrence, whilst if the goods are delivered direct from brewery or agency into the customers' cellars, such questions seldom, if ever, arise, owing to the brewer being able to exercise more perfect control over the beer, its subsequent condition on tapping being influenced by fewer contingencies.

But, apart from long-distance delivery, owing to the much greater speed of the power-propelled dray, short and medium distances can be covered, and their loads delivered in so much less time; empties, as a consequence, being very much more quickly brought back to the brewery, which in the busy season, as you will all agree, is a matter of no slight importance. Firms using these steam drays say that they find them also a most useful check on the drivers of their horse wagons as to the time they should take over a journey.

Power.—Undoubtedly the practical value of a steam dray greatly depends upon the power of the engine with which it is provided, while that engine which will give out the highest power with the lowest number of revolutions per minute will, other conditions being equal, have the longest life; but, next to a well-powered engine, general excellence of design ranks in importance, as was clearly proved at Liverpool by two of the competing vehicles, each had engines of virtually equal power, yet whilst the one obtained the gold medal, the general performance of the other was inferior to a degree.

Surprise has often been expressed by the uninitiated at the apparently great power needed for the propulsion of heavy motor drays; the explanation is, however, really quite simple. In the first place, the horse has a very large reserve of strength beyond that which he puts forth in average working, which, in virtue of his intelligence, he is able to exert when required. This extra tractive effort has been tested by experts, and found to equal as much as 17 engineers' horsepower; this high rate, however, is developed naturally for only a very short space of time, such as when starting a heavy load, dragging out of a soft place, or ascending a short stiff rise.

So that although three horses would be generally found sufficient to draw a 14-barrel load, a steam-engine of 3 H.P. would be utterly useless, as it is evident we must have a motor fully capable of dealing with the heaviest work likely to be required of it. But a 17 H.P. engine would still not satisfy our requirements, as a large allowance must be made for friction in the transmission between the piston and the driving wheels, and this is generally estimated as being equal to one-third of the total power of the engine; therefore the actual effective B.H.P. of the motor for a 3-ton dray would be $17 \div \frac{2}{3}$, or not less than 25 or 26 B.H.P. But the more ambitious of our steam-dray builders go further than this, and engine their vehicles to climb gradients of 1 in 6, which no horse with a like load could possibly negotiate. But with the speeds and pressures now safe and in constant use, an engine of 25 to 30 B.H.P. or more is a very small affair, weighing under 5 cwt., and stowable in a box $3\frac{1}{4}' \times 2\frac{1}{2}' \times 1\frac{1}{2}'$, having ample bearing surfaces to ensure durability in continuous running, and a good constant lead, variable cut-off and reversing gear, enabling the power to be varied within wide limits (from 5 to 15 I.H.P. or more) with very great economy. The range of power can be still further widened by varying the boiler pressure, whilst the provision of a second or slow-speed gear between the engine and final drive materially assists the negotiation of steep ascents and starting with heavy loads on soft or sandy roads. From the foregoing remarks it will be clear that such a motor will do far more useful work than the horses it nominally replaces; its great elasticity putting it also far ahead of all other systems of propulsion.

Control.—The general control, starting, steering, and stopping of these automobiles when working on the road amongst dense traffic,

will be found decidedly superior to the best types of horse-drawn vehicles. The facility with which they reverse, coupled to the fact that they take up much less space than a horse wagon, enables them to work in and out of an embayment one and a half times their own length; this clearly shows that they are capable of going anywhere where horse-drawn vehicles are ordinarily required to go.

In the matter of hill climbing, motors are distinctly superior to the horse, as was clearly demonstrated on the cobbles and sets at Everton Brow, Liverpool, when a load of $6\frac{1}{2}$ tons was taken up the incline of 1 in 9, stopped midway up, and started again without a hitch. The power of control down hill was equally remarkable, showing that the stopping distance at full speed is incomparably less than that required by horse vehicles, due to the provision of very powerful and effective brakes and the ability to reverse the engine.

Steering.—Absolute command of the steering is naturally of the highest importance, the system almost universally adopted is Ackermann's controlled by worm gearing and a hand wheel, this having been found to be the most reliable. Care should be exercised that no play or slackness exists in the connections, but while being certain it should not be too slow in its action.

This superior controlling power that the driver of an automobile has over his vehicle in comparison with one horse-drawn seldom, if ever, occurs to the lay mind. In a horse-drawn vehicle there are two powers at work, in case of sudden necessity, either for stopping or change of direction, viz., the brain of the driver and the brain of the horse, which together govern the movement of the vehicle which he is drawing.

Operating Gear.—Although the driver of a motor wagon should have more skill than the average brewery dray-man usually possesses, the actual management of the best vehicles is really not as difficult as their novelty would lead many perhaps to suppose. In the better arranged steam drays all gauges, levers, and valves are immediately in front of and easily operated by the driver while seated; their handling after a few days practice being simplicity itself.

Although much time, labour, and money are being expended by several firms in perfecting drays absolutely automatic in their action, I think the numerous parts and complications all depending for satisfactory working on the behaviour of each other scarcely tend to real

value in practice. The more simple the mechanism of a road vehicle the better, and if a man has not sufficient skill to drive such a vehicle he would be unfit to trust with even an automatic one.

Maintenance.—In addition to being proficient in the actual driving, the driver should know every detail of the construction of his vehicle and take a personal interest and pride in its condition and appearance, he should be held responsible for its good running, to which end provision should be made both in time and facilities for proper and regular adjustments to be effected; as every brewing firm as a rule possesses an engineer's shop or bench, the only further requirements would be a sufficient stock of spare parts likely to require renewing. Drivers must therefore be sufficiently skilful to execute small repairs on the road, or at home. Where an inferior or hard feed-water has to be employed, it is customary for the boiler and tubes to be thoroughly cleaned inside and out regularly once a week, when the necessary adjustments to the mechanism are made.

Remembering the great strain and jar to which these vehicles are subjected in use, the truth of the old adage respecting "a stitch in time" cannot be too seriously impressed on drivers and owners alike.

Durability and Depreciation.—So closely are maintenance, durability, and depreciation connected that it is impossible almost to discuss any one of them by itself; durability depends first of all on the original design and construction of the vehicle, including among other things a large margin of strength in the various parts, suitable distribution of tare load, large bearing surfaces, accurate workmanship, the best of materials and ample power in both engine and boiler that nothing shall run the risk of being unduly strained. Next to original design comes care in use; unfortunately the "sporting" instinct almost invariably causes drivers to maintain a higher speed than is consistent with fair wear and tear; while the "commercial" instinct of owners is conducive to equally regular over-loading, both habits being seriously detrimental to the working life of a motor vehicle originally designed for certain loads and speeds.

The figures estimated for a year's repairs by the Liverpool judges for the different vehicles competing at the heavy trials form very significant reading and point in no uncertain manner to the greater economy in use of the best class of steam drays. While they estimate

13·4 per cent. on cost price for these superior machines, the percentage runs as high as 26·7 for others of inferior construction.

Depreciation being therefore greatly dependent on original design, careful use and prompt repairs, the actual figure generally accepted for this item is 15 per cent., which provides as much for antiquation as deterioration. From the foregoing remarks it will, therefore, be gathered that automobiles form no exception to the rule that the best is always the cheapest.

Economy.—In estimating the pecuniary and practical value of a steam dray, the only correct method to adopt is to compare the maximum work it is capable of with that of a horse-drawn vehicle of the same capacity, and as 3 tons is approximately the weight of a full sized brewer's dray load of 15 barrels, this will be a very convenient basis to work upon. Now the maximum work such a steam dray has got through in a day was 152 net ton miles, or in a working year of 260 days (this computation leaving out those days on which usually no work would be done) a total net ton mileage of $152 \times 260 = 39,520$ would be secured. The owners of the particular steam wagon which actually did this work consider that it easily replaces three of their two-horse drays, that is three drays, six horses, three drivers, and three stillagers.

Now the recognised standard of work a horse is capable of performing is 14 N.T.M. per day on ordinary turnpike roads, and two horses harnessed to one wagon may achieve say 35 net ton miles daily in regular work; 152 net ton miles per diem will therefore require $\frac{152}{35} = 4\cdot3$ two horse units, or say nine horses. This result suggests that in the estimate just mentioned, three two-horse wagons should be altered to three three-horse wagons, but for argument's sake, and to be thoroughly on the safe side, we will take the firm's own officially attested estimate of three two-horse lorries with attendants, the cost of which will work out as follows:—

<i>Prime Cost of Horse Drays:—</i>	£	s.	d.
Three 14-barrel drays at £60.....	180	0	0
Six strong brewer's horses at £70	420	0	0
Six sets harness, rugs, &c., at £7 10s....	45	0	0
	<hr/>		
	£645	0	0
	<hr/>		

<i>Working Expenses of Horse Drays:—</i>	£	s.	d.
Interest at 5 per cent. on £645	32	5	0
Depreciation at 15 per cent.	96	15	0
Fodder and bedding at 12s. per week	187	4	0
Insurance at 2 per cent.	12	18	0
Repairs to drays, harness, &c.	24	0	0
Shoeing at 1s. 6d. per week each	23	8	0
Horsekeeper (share).....	46	16	0
Veterinary surgeon.....	6	6	0
Rent, rates, and taxes.....	46	4	0
Three drivers at 25s.	390	0	0
Three stillagers at 18s.	140	8	0
Total	£1,006	4	0

	A.*	B.†
<i>Prime Costs of Steam Dray</i>	£590	£700

Working Expenses of Steam Dray.

	£	s.	d.	£	s.	d.
Interest at 5 per cent.	20	10	0	35	0	0
Depreciation at 15 per cent.	88	10	0	105	0	0
Insurance at 2 per cent.	10	18	0	14	0	0
Rent, rates, and taxes	5	5	0	5	5	0
Repairs (material and labour).....	100	0	0	100	0	0
Fuel, 8·88th S.W. coal per vehicle mile × 51 × 260 = 52·56 tons at 20s.	52	11	5	—		
Ditto, ditto, at 25s.....	..			65	14	0
Ditto, for raising steam.....	6	10	0	8	2	6
Wood for lighting fire	0	15	0	0	15	0
Water, 7·15 per vehicle mile × 51 × 260 = 94,809 galls. at 1s. per 1,000 galls.	4	14	10	4	14	10
Lubricating oil and waste.....	10	0	0	10	0	0
Wages, driver at 35s. per week	91	0	0	—		
Ditto, ditto, at 40s. per week	..			104	0	0
Stillager's wages at 18s. per week.....	46	16	0	46	16	0
Totals	446	10	3	490	7	4

* Column A, Liverpool judges' estimate of costs.

† Column B, Mr. Hoyle's suggested amended estimate of costs (see p. 215).

Comparison of Working Costs between Horse-drawn Drays and Steam Wagons.

	A.*	B.†
	£ s. d.	£ s. d.
Annual cost for horse-drawn dray to carry 8 tons	1,006 4 0	1,006 4 0
Annual cost of steam dray to carry 3 tons....	446 10 8	499 7 4
	550 13 9	506 16 8

The Motor Dray.

The general design, as will be seen from the illustrations provided of the vehicles at present on the market, differ very considerably, while three adopt a cab in front, two dispense with this erection. The extreme length of these drays ranges from a little under 16 feet to slightly over 18 feet, the platform area available for loading varying from 56 to 71 square feet, according to the disposition of the boiler and machinery; the extreme width is limited by the Act to 6 feet 6 inches.

The framing is almost, without exception, of channel steel, the wheels are either of the military type with metal naves, oak spokes, and ash felloes, or built up entirely of iron or steel; the latter are, however, not to be recommended, as the jars to which they are continuously subjected soon shake them to pieces; a metal wheel not possessing the same resiliency as one in which wood forms an integral part. For use abroad, where the ravages of white ants and other insects render the employment of wood impracticable, steel disc wheels are the only suitable form to adopt; they are, however, very heavy and cumbersome. The driving power is transmitted to the rear wheels, while the vehicle is steered with the front ones.

According to the purposes for which it is required, the platform may be either flat or built in the form of a brewer's dray, while if of the former description it may be provided with hinged sideboards, fixed open sides, or may be built in the form of a van, it being possible

* Column A, Liverpool judges' estimate of costs.

† Column B, Mr. Hoyle's suggested amended estimate of costs (see Discussion, p. 215).

to employ several different forms of bodies with the one motor frame, which is naturally a great convenience.

The Motive Power.—For passenger cars and other light vehicles we have at our disposal electric and internal-combustion motors and steam engines; for heavy freight-carrying wagons, however, electricity is quite out of the question, the great dead weight of the accumulators necessary to store the requisite energy being apparently an insuperable difficulty, where the mileage is as much as 40 per day and the load fairly heavy; their high cost and short life also greatly militating against their use for vehicle propulsion, as in this service disintegration takes place much more rapidly than in a stationary battery owing to the vibration of the vehicle.

Oil (or more correctly petrol) engines gave satisfactory results in the heavy trials in connection with the Automobile Club Show at Richmond in June last, obtaining a gold medal for general efficiency; they maintained an excellent speed, and the oil consumption was remarkably low. For regular heavy work, however, they are somewhat complicated and delicate in construction, require too much looking after, and are extremely sensitive to atmospheric influences, while variations in speed are entirely dependent upon gearing, there being no elasticity in the oil motor as in the steam engine.

It will, therefore, be seen that steam is the only suitable form of motive power for such vehicles as brewers' drays and bottle lorries, not only on account of its reliability, but also on the score of much greater simplicity, economy, and flexibility, *i.e.*, the wide limits within which the power of the motor may be varied without the use of complicated mechanism, this of course being effected simply by varying the quantity of steam admitted to the motor, or by varying its pressure or by both.

But a steam engine requires a boiler, and this, for use on an automobile, must needs be small, light, of great strength, and capable of quickly making steam at the right pressure and in sufficient quantity. It necessitates the carriage of a quantity of fresh water in one or more feed tanks, and a sufficiency of fuel, either solid or liquid. Remembering that the law restricts the tare weight of the vehicle to 3 tons, we see that the construction of a boiler to meet these requirements is no easy matter. In general, that type of generator should be chosen which has large heating surface, great evaporative power, simplicity

of construction, and general accessibility. Above all it is necessary that it should be constructed of material and to a design that will pass the recognised boiler authorities, such as the Admiralty, Lloyd's, the Board of Trade, or the leading boiler insurance companies. The great advantage of this course is that it ensures a reasonable factor of safety, and moreover shows that the user took reasonable and proper precautions. Unfortunately many of the steam generators at present in use are built without any such official inspection or testing, they are very light in construction, offer a very small factor of safety, and have but little endurance.

There are three types of generators at present employed on various vehicles: the "water tube," "fire tube," and "flashing" type. Of the first named there are more varieties than of any of the others; under this category are included the Thornycroft curved and straight tube boiler, as designed by this celebrated firm for use in their torpedo-boats; the Lifu, constructed by the Liquid Fuel Engineering Company, of Cowes, Isle of Wight; the Sarjeant launch boiler; the Toward, built by the firm of that name at Newcastle-on-Tyne; the Merry-weather, originally designed for steam fire engines, and now adopted by Messrs. Clarkson & Capel for road locomotion; and the French de Dion et Bouton, which is a very heavy affair, weight being no object in France, a modification of the latter is, however, employed in this country on the Bailey steam dray. Without doubt among these water tube generators we find the most suitable type for road work, they having given, under practical and continuous work, results far in advance of any other form; they are simple in construction, most economical in fuel consumption, they possess the highest efficiency in point of evaporative power, are easily accessible for cleaning and repairs, and are undoubtedly the safest, but on the other hand they are certainly somewhat costly.

The only fire tube automobile boiler of any note is the "Leyland," as employed in the vehicles constructed by the Lancashire Steam Motor Company and Messrs. Coulthard. This is a vertical generator, simple in construction, with tubes of less diameter at the top than at the bottom; it gives satisfactory results in regular work, and owing to its lower cost materially assists in the production of a fairly reliable and comparatively inexpensive motor wagon. This boiler, although generally oil fired, is equally satisfactory if coke is employed.

The "flashing" or "waterless" boiler, as it is sometimes called, originally designed by Serpollet, is, like the de Dion et Bouton water tube boiler, of French origin and very heavy, and although little suited for employment in the construction of vehicles restricted to a 3-ton tare, has been tried by several experimental firms in this country. This type of generator is based upon the principle of injecting small bodies of water into a battery of specially shaped tubes connected together, placed in or over a suitable furnace, the water being at once flashed into steam much in the same way as a drop of water is on a hot stove plate. The tubes to withstand the extreme wear and tear of the dry heat when empty, and the sudden charging while red hot with water, must necessarily be of considerable weight and of the highest class of metal. The most notable of these is the original "Serpollet," which is composed either of twisted tubes or of tubes having a kidney-shaped section, the annular space through which the water and steam pass being only about one-eighth of an inch.

Messrs. Simpson and Bodman, of Manchester, have built up a flash-type boiler of heavy Mannesmann steel Row indented tubes, connected together by means of Haythorn joints. The Musker and the Blaxton generators consist simply of coils of exceedingly strong steel tubing of small internal diameter. The two latter are fired with liquid fuel, the Simpson-Bodman and Serpollet systems employing coke.

The advocates of "flash-type" boilers put forward very specious arguments in favour of this form of generator, the fact of having only very small bodies of water under pressure at a time, especially when travelling through crowded streets, would tend to the encouragement and adoption of such a system, but among well-informed engineers this apparent advantage is heavily discounted, for one thing, the steam produced is superheated, in some types, to an enormous extent, necessitating special provision in the construction of the engine. Further, the inherent weaknesses of this system are so many that it is very doubtful if it will ever come into general use. So far, with the exception of the "Serpollet," they are all only in their experimental stage, none having passed through the searching test of actual lengthened road service, or even such as would have been given them at the Liverpool Heavy Trials.

Fuel.—For steam-raising purposes the fuel may be either anthracite coal, coke, or petroleum; but, as in locomotives, the fuel most usually

employed in steam motor vehicles is coal; this, however, has to be of the best smokeless quality, as the law prohibits the emission of any smoke or visible vapour. For this reason coke is often preferred, but it is, of course, inferior to coal in evaporative power: 1 lb. of Welsh coal will in a good steam generator turn $8\frac{1}{2}$ to 10 lbs. of water into steam, whereas 1 lb. of coke will only evaporate 8 lbs. of water. Although coal and coke are somewhat objectionable, as they mean the production of dust, dirt, and ashes, and occupy much space in stowage, it is a most significant fact that, notwithstanding the peculiar convenience and advantages of petroleum, among which may be mentioned its great evaporative power (1 lb. of petroleum evaporating 16 lbs. of water), several motor makers who have made oil burners a speciality are now suggesting the use of coke in preference. The reason is that, on a steam road vehicle, simplicity is an absolute *sine qua non*, and anything that introduces complications such as are indispensable for the employment of liquid fuel is best avoided. Another great objection to the use of petroleum for steam wagons is the roaring noise it makes during combustion, although it must be admitted that some burners are less noisy than others. The most successful petroleum burners, as used on motor vehicles, are the "Leyland," "Lifu," and "Clarkson and Capel." These are all of the vaporising type. But, apart from the complication and noise, anthracite coal is really in practice the cheapest fuel to employ in point of efficiency.

Condensers.—The form employed for motor work is what is known as the air condenser, and consists of coils of thin copper tubing furnished with numerous radiating gills or flanges so as to dispose the large radiating surface to the air; its position materially affecting its efficiency, it is customary to either place it on the top of the cab or in front of the vehicle, where it will meet the strongest current of air. One of the most effective condensers is the Clarkson Capel, the radiating surface being greatly increased by means of rows upon rows of thin rings fastened spirally round the ordinary tube. To further increase the efficiency of the condenser, a fan driven from the engine may be employed, but, as this will absorb about 12 per cent. of the power, and form a further complication in design, it has little to recommend it.

The two purposes for which condensers have been considered indispensable by some motor vehicle constructors are that they dispense

with the necessity of carrying large quantities of feed-water and help to render the exhaust invisible; practical experience, however, shows that where water is obtainable at points not more than 15 miles apart it is questionable if a condenser is of any real advantage unless its efficiency is very high. Again, the air condenser, of course, gives no vacuum; indeed, if not suitably arranged, it greatly increases the back pressure of the exhaust, thereby lowering the power of the engine considerably. The condensed steam also is very often contaminated with grease so as to be unfit for boiler use. Three of the competing vehicles at Liverpool using condensers did not lubricate the cylinders; this must necessarily prove a source of excessive wear in such cylinders. A fourth vehicle, fitted with this contrivance, employed graphite lubrication. Filtration might overcome the difficulty, but the opinion of the Judges was that the great attendant disadvantages of increased cost, weight, and complication, the latter both by reason of its own construction and of the additional piping and connections involved, more than outweighed the two nominal advantages the use of a condenser confers, namely, less deposit of lime in the boiler and the need of carrying a small feed-tank only. The further advantage of hot feed is easily obtained otherwise by constructing the exhaust-silencing vessel as a feed heater from whence the exhaust steam is conducted to a blast nozzle at base of uptake, where it is at once superheated and passes out of the funnel as an invisible vapour.

The steam motors employed are small, and run at a high speed of revolution; both horizontal and vertical types are in use, and they are generally of the two stage or triple expansion pattern, in some instances the engines are only uni-direction.

The power of a steam motor depends upon the size of the cylinder, the mean pressure of steam, and the number of revolutions per minute. In order, then, to obtain a large power from such small motors as considerations of space and weight require to be fitted in motor vehicles, the necessity of high steam pressures and a high speed of revolution will be at once apparent; while, in order to derive the full benefit of the high pressure steam, the use of compound or triple expansion engines is equally compulsory. Owing to the high speeds employed, ample bearing surfaces and automatic lubrication to every moving part are two indispensable provisions in the construction of these engines. When it is considered that the law restricts the weight

of a motor vehicle to 3 tons, it will be allowed that no small engineering skill is required to include in this weight the vehicle, boiler, motor (which at times must be capable of developing 30 H.P. and over), water and oil tanks or coal bunkers, pump, injector, gauges, and many other details, all of which mean weight and space.

One of the best engines so far designed for motor vehicles has high and low pressure cylinders, the former 4 inches in diameter, the latter 7 inches in diameter by 5 inches in stroke. Steam at a pressure of 175 lbs. per square inch is used, while with an engine speed of 440 revolutions per minute 20 H.P. is developed; with a slow speed pinion in gear the power is increased to 35 H.P., with a corresponding engine speed of 770 revolutions per minute.

The relative horse-power for given loads is, however, anything but uniform, and clearly shows why the cost prices of vehicles vary within such wide limits; while one firm gives an engine with an available horse-power of 35 for a load of 3 tons, another will allow only 14 B.H.P. for a load of nearly $4\frac{1}{2}$ tons. The practical value and working life of a steam dray, as has already been pointed out, depending to a very great extent on the available power in the motor, it is not difficult to assess the service likely to be rendered by each of these vehicles.

Transmission.—From the engine to the road wheels the power is usually transmitted by means of spur or bevel gearing to an intermediate or counter shaft, and thence through differential gear and sprockets and chains to the driving wheels. The great difficulty in all self-propelled vehicles has been to provide a continuous driving effort without impeding the free and independent play of the bearing springs; chains being flexible connectors have enabled the difficulty to be overcome, but so far not in a very satisfactory way. It is found that, unless made exceedingly large and effectually encased and lubricated, their life is very short, and the replacement of worn out driving chains forms an important item in the repair account of chain driven vehicles. For light vehicles the objection to their use is not so great, while it is quite possible that when the requirements of heavy road service are more widely understood, makers will be able to produce chains capable of giving complete satisfaction. The two makes of chains which so far have best complied with motor vehicle requirements are Hans Renold's "silent" chains and Bramptons, the first named being found on nearly all chain-driven heavy steam lorries.

In those cases where chains are dispensed with, plain spur or helical gearing is employed ; this involves very careful and accurate fitting, and perhaps it is needless to add, helps to increase the prime cost of the vehicle ; but the greater outlay is fully justified by the more certain action and almost everlasting wear of the gear.

Weight Distribution and Adhesion.—The importance of placing as much as possible of the weight of the vehicle upon the driving axle is scarcely to be over estimated, as if attention is not paid to this matter the full propulsive effort of the engine cannot be effectively applied when the wagon is running light ; the erratic performances of one or two of the competing steam wagons at Liverpool were to a great extent due to neglect of proper precaution in this direction.

This, I think, completes the consideration of the actual vehicles.

In conclusion, I would again point out that although absolute finality may not yet have been reached in the construction and design of steam drays any more than it has in locomotives, there is no valid reason whatever for firms to delay any longer in availing themselves of the use of these economical horse substitutes.

Had this new form of locomotion no forerunner, there might be some excuse for doubting its reliability, but in the railway locomotive, traction engine, tramcar, torpedo-boat, and similar branches of engineering, the rough details of the motor wagon have already been perfected. So that really their adaptation to the new type of vehicle is, comparatively speaking, a small matter.

So long as makers will keep to systems which have been proved by years of practical experience to be satisfactory and reliable, and shun theories and experiments, success is fairly certain.

It only remains now for me to thank you for the kind attention you have accorded me, and to express the hope that my endeavours to interest you in a question which is undoubtedly of very great importance to the brewing industry, may have been successful.

DISCUSSION.

The SECRETARY announced that he had received a message from Mr. Alderman Charles Tetley, regretting his inability to be present owing to a slight accident.

Mr. C. F. HOYLE said that he had been struck with the author's

remarks, and one point which interested him was the evident economy of working. He gathered from the paper that Thornycroft's was the best machine. The boiler was the best for taking out and cleaning. He should like to ask Mr. Maynard whether, if he were himself constructing a machine, he would divide the various parts between various makers, taking, say, one firm's boiler, another firm's machinery, and another firm's cab, or would he take one of the machines exactly as it stood? He thought that in connection with the tubes of Thornycroft's boiler, they could easily be taken out and replaced, and that was a decided advantage.* In the figures given by Mr. Maynard the cost of the machine was stated to be £590, and he had based his calculations throughout on that price. But he (the speaker) thought there must be some mistake, as Messrs. Thornycroft were charging them £650 each for two such machines. The machines he referred to had one tank; he preferred that form, as they had been running a traction engine for some years, and they knew exactly where the water points were in the district, and that only one tank would be required. The machine he referred to had the two coal bunkers, and was in fact exactly the same machine as that shown by Mr. Maynard on the screen. He felt sure that such a machine could not now be bought for £590, and in confirmation of that statement referred to a report in the *Autocar* for the previous week, where it was stated that a Lincolnshire corporation had asked for tenders, and the tender of Messrs. Thornycroft was for £700 for each machine. The prices quoted to his firm by Messrs. Thornycroft were £650 for the machine with a cover, and £610 without. They were now three weeks late in delivery. He should also like to ask whether Mr. Maynard would be satisfied with 15 per cent. for depreciation as calculated? Would he not prefer to allow something for extraordinary depreciation and repairs? According to the calculation made by Mr. Maynard, it would mean a new machine every $7\frac{1}{2}$ years. He himself was under the impression that if they would last only four years they would pay, and that of course meant a depreciation of 25 per cent. He did not wish to appear sceptical, but there were one or two items to which he might call attention. For instance, good cannel coal could not be got in this district for 20s. per ton, it would be nearer 25s. he thought. There was a steam dray made by Mann's: could Mr. Maynard give them any comparisons

* For estimate of costs on Mr. Hoyle's suggestion, see column B, p. 207.

between the two machines, Mann's and Thornycroft's? He himself had seen one of Mann's machines, and the great difference between their machine and Thornycroft's was the amount of space occupied by the machinery. In one case the space occupied by machinery was twice as large as in the other, and if there was one thing against Mann's machine it was, he thought, although he had no pretensions to being an expert, the weight of the boiler and the machinery. When he saw Thornycroft's machine they went out beyond Chiswick, and crossed the railway where there was a steep gradient. He asked them to stop in the middle of the gradient, in order to see whether they would make use of the reversing gear, or whether they would use the brake power alone. He remarked to the engineer that the rate of travelling was somewhat slow. However, the machine certainly travelled at 6 miles an hour. They had on a load of pig metal. There were great advantages it must be allowed over the traction engine. In the case of a traction engine it required 30 or 40 barrels to make up an economical load, but this quantity could not be delivered in one day, and they could not get their public-houses to take sufficient in one district for such a load. With a motor dray it would be possible to take out a load for three houses, so that there was a great difference and more economical working compared with the cumbrous load of the old traction engine. They used to send four men out with the engine, and the publicans did not care to provide dinner for them all. In addition to this there were many other difficulties in connection with the ordinary traction engine. He hoped that with the smaller loads the motor drays would be found much more economical. He wished Mr. Maynard was right in suggesting that a good driver might be had for 35s. He thought that was rather low, as of course everything depended upon his being a good man.

Mr. MAYNARD, in replying, said that, without wishing to hold a brief for any firm, he must say that the Liverpool Heavy Trials, which were entirely independent, proved that Thornycroft's machine was built on the best lines. So far as he could see, Thornycroft's was by far the best boiler, and was very easily getatable. The Bailey steam lorry people claimed that their boiler had a greater evaporative power than Thornycroft's; there had been a good deal of correspondence on the subject, but he was of opinion that Thornycroft's was superior. At the Liverpool Heavy Trials one of the tubes burst, and Mr. Thorny-

croft, Jun., who was present, replaced the tube and caught up to the other wagons, which proved to his mind that the replacing of a tube was not a very difficult matter. The figures he had given for the cost of the machine were those stated in connection with the Liverpool Trials, and he was not aware that there was any alteration. Of course there were different types of wagons, which would naturally vary in price. The figures in connection with depreciation were not his own, but he had given them as they were stated by the Liverpool judges. Fifteen per cent. was the amount they decided upon as meeting all requirements. Extraordinary depreciation, he believed, was allowed for in the figures named for repairs. The amount for repairs varied from 13·4 per cent. to 26·7 per cent. According to the Liverpool judges, it would certainly be an easy matter to keep the machine going for six to seven years. He had not seen a Mann's machine. He had written to all the leading makers, but, as a matter of fact, had no reply except from Thornycroft's. He was given to understand that Mann's machine exceeded the legal tare. They stated that they had a tractor and a trailer, and that one weighed 3 tons 19 cwt., and the trailer 1 ton. But the two together must not weigh more than 4 tons, and the motor itself must not weigh more than 3 tons. It was very easy for them to say that they could put so much on to a machine, but the point was how long would it stand it, and what was the brake power? With regard to the wages to be paid to a driver, he had taken the figures again from the Liverpool trials.

Mr. HOYLE, in moving a vote of thanks to Mr. Maynard, said the motor car had come at a period when he had no doubt it would meet a need that was beginning to be felt, a need that would be felt in the near future more than it had been in the past, a need that arose through the great difficulty in connection with horse-flesh. The troubles which they as brewers had to face in the matter of horse-flesh could not be measured. There was the carelessness of draymen, the watering of horses when hot, together with the diseases of various kinds to which the horse was prone. Recently they had as many as about 30 horses all down at one time with "pink-eye," annoyingly frustrating their arrangements for delivery, and making it almost impossible for them to carry on their business. Motor cars might be subject to irregularities of procedure, and, no doubt, at times they would act in an erratic manner when not properly restrained, but with all that it was

in the driver's power to control them, whereas, in the case of a horse, that was not always so. The one thing which affected them most as brewers was the matter of economy. If they could only realise half the savings that Mr. Maynard had suggested, he had no doubt they might look upon that gentleman as the pioneer of something that would be of much greater importance than he expected at the present moment. The tendency would be to give a fillip to an industry that was very dear to them all, even if it added one more loss to the agricultural labourer, and that was the iron and coal industry.

Mr. LINLEY seconded the vote of thanks, which, on being put by the Chairman, was unanimously carried.