some comparisons of cost of English and American wheels, and shows that, if the London and North-Western Railway were to adopt the American wheels, they might save £120,000 a year.

Extract from the Report of Augustus Morris, Commissioner to the Philadelphia Exhibition in 1876, to the Government of New South Wales.

"I am confident that the construction of American locomotives and rolling-stock will enable us more readily to imitate them than the more complicated English patterns. I think I have stated sufficient reasons for concluding that the former have many points of superiority over the latter, and are better suited to colonial requirements. The railways of America are remarkably smooth and easy to travel on; serious accidents from defective construction are rare. Not a single accident occurred during the conveyance of the enormous multitudes of people to and from Philadelphia during the Exhibition which could possibly be charged to the neglect of the officials. The manufacturers have produced a locomotive engine which, for simplicity of structure, for power and economy in working, as well as for cheapness, compares most favourably with those of England or Belgium. I consulted those eminent engineers who were sent by the Russian, the German, the Austrian, and other European Governments to report on American railway plant, and my conclusions are theirs. They gave the preference to the best American locomotives over the English for the requisite qualities."

Extracts from Articles by Mr. T. Passavant, Mechanical Engineer, published in the "Glasgow Practical Mechanics' Journal."

Vol. 2, page 76. Mr. Pasaavant, in a paper on the Construction of Locomotives, gives the dimensions of two, one by Sharp, of Manchester, and one by Norris, of Philadelphia. He then gives the daily duty of these engines (the English engine weighed 21½ tons, the American, 14 tons), and shows that the duty of the English engine, as compared with the American, was as 1¾ to 1, while the power employed was as 3·9-10 to 1. He then goes on to say, "The alterations in the construction of locomotives attain their highest value when outside cylinders are employed. A general opinion exists that outside cylinders will not do for high speed; this may be considered a mere prejudice. I have experimented on outside cylinders up to 55 miles an hour, and found them equally as steady as inside cylinders. The outside-cylinder engine possesses very great advantages both as regards safety and economy."

Vol. 2, page 217. "Such engines as were originally imported from England failed on the American lines; the paying duty bore no just proportion to their absolute power. It was soon seen that to copy English engines would be ruinous to the pecuniary interests of the roads. The inventive spirit of the American was roused to build an engine to suit their roads. Experiments were made, principles were developed now universally adopted, and the engines are enabled to go over arduous, heavy lines with a speed equal to that used in England, and with equally heavy trains. Some of these principles would add considerably to the durability and effective power of an English engine, but the latter, as it now is made, would be of very little use on American roads. The first great alteration was in 1833, in altering one of Stephenson's engines, by putting a bogie in the place of the leading axle. The engine could then pass, with perfect ease and safety, and at its highest speed, through curves on the main track such as in Europe would not be considered safe even in sidings at stations. The next alteration of great importance was the substitution of the straight axle for the crank axle. This, with the truck, completely altered the character of the locomotive. The same genius which thus altered, perceived the necessity for a framing more rigid than the usual one, and an entirely new construction was introduced, possessing great lateral stiffness. Why was this necessary? On outside-cylinder engines being built in England, instead of a stronger a much weaker frame was used. In England engines with inside cylinders have always been constructed with two frames on each side: one only carries, but the second one contributes greatly to the lateral stiffness of the whole. This is not necessary, as proved by many such engines being constructed and successfully worked in the United States with only one frame. On the cylinders being placed outside the engines were found to oscillate much more. To resist this the only way was to stiffen the engine laterally. This was the object of the new American frame. What was done in England to oppose this injurious tendancy? If the causes that produce oscillations had been well understood the slight plate frames would not have been generally introduced for this class of engines in England. For comparison, I will take two engines—No. 1, English, by Sharp; No. 2, American, by McQueen: No. 1 has cylinders, steam-chest, smoke-box, and chimney overhanging the point of support by upwards of three feet. In No. 2 the frame plates are in front themselves, carried by the truck frame, the vertical strain on them being, therefore, less. This support is placed underneath, or very near the centre of, the cylinders. Overhanging weight there is none; the tendency to oscillation is therefore removed. We find, moreover, in No. 1 a rigid leading axle, unavoidably subject to straining in curves, and is one cause of oscillation. In No. 2, we find the truck movable around a centre-pin, the wheels and axles adjusting themselves to the curvature, thus removing a great cause of wear and tear and loss of power. Were the form of the frame-beam the same, with the above points of difference, we should rightly suppose No. 2 a more steady-going engine, but in the construction of these beams itself we find a better proportioning of material for the purpose for which it is designed in No. 2. The frame of No. 1 is of iron, 8 in. x ⅞ in.; its strength to resist a force acting against its sides is 4,044 pounds. The American frame consists of a bar of iron, 2 in. x 4 in.; its strength to resist a force acting against its sides is 13,600 pounds. The surplus strength of the English engine in no way contributes to the lateral stiffness of the structure; in the American engine it does altogether. Which of these two frames is the most scientific and, at the same time, the most practical? Of two engines of equal power, which will produce the greatest useful effect? The one that works most easily and has the least oscillation and strain. Which will have the greater durability, and therefore be more economical? The one that possesses greater steadiness of motion. Another advantage of the American frame is the saving of expense in material and labour of construction. These are the great principles by which American engineers have successfully attempted to give steadiness, stability, and durability to their engines; the above three qualities of a locomotive, or the three virtues, are solely dependent on a well-constructed frame."

Vol. 3, page 23. "I gave my views for rendering an outside-cylinder engine steady. By reasoning I came to certain conclusions, which existed simply as theories. Arriving in the United States, I found such engines had been built that were remarkably steady. It may seem bold to place an engine by one of the most renowned firms in England in juxtaposition with one built at a railway workshop in a town the name of which is scarcely known in England, but a glance at the drawings will convince the most sceptical how the one must be unsteady, containing within its construction the very cause of oscillation—high boiler, insufficient fastening of cylinders, and great overhanging weight; while the other will move along the road as smooth as possible."

Vol. 3, page 242. "To start a railway in opposition to the magnificent Hudson River (where the steamers are fitted with a luxurious elegance which, to the English traveller, was incredible, and when competition had reduced the fare to the lowest standard of profit) was a hazardous undertaking. The Hudson River Railway was opened for traffic in 1849. It is crooked, with many quick and serpentine curves, running along the whole distance; the greater part is protected by a river wall. The actual speed of express trains is 44½ miles an hour; for a great part of the line the speed is above 50 miles an hour. We have praised the American engines and must expect that the sample we bring will be diligently, perhaps invidiously, compared with English engines, and must be prepared with positive proofs of the excellence of the engines. The accompanying drawing of the 'Champlain' represents one of the engines on this railway. . . . She is worthy to be placed by the side of the best English engines, both as to mechanical construction, the duty she has performed, and the elegance of her general design. Her dimensions are: cylinders, 15 in. x 20 in.; four driving wheels, 66 inches diameter; heating surface, 824 square feet; weight of engine, 47,360 lb.; weight on driving wheels, 30,060 lb. The trains average one baggage and five passenger cars, all the cars on two 4-wheeled trucks. The cars have seats for sixty passengers each. During the summer we have often seen this engine with from eight to eleven cars keeping her running time, the cars not merely filled but crowded with passengers. Taking one of their trains, it will weigh 128 tons. This is a heavy train for an engine of that size to propel at 44 miles an hour—on many parts at nearly 60 miles. . . . There are many curves on this road such as will not be found on English roads. The American passenger engine performs more work. There is more work got out of her than is generally obtained from the English passenger engines. . . . The American passenger engine has many solid advantages in its construction—the almost universal use of double drives is one of them. . . .