over eight millions of tons in a year, besides a heavy passenger traffic, and being forced, by great competition, to a close study of railway economy on all points of expenditure, it may not be uninteresting to the *professional man* to state some of this data given to Mr. McDonnell. The importance of a close study of economy on this railway was made evident by the president, Mr. Gowen, in one of his annual reports, when he said that an additional charge of 1·20th of a cent. per ton per mile in their coal traffic would be equivalent to an additional dividend of 2 per cent. on their entire capital. They had in 1875, on 95 miles of railway, 410 locomotives. The average weight of coal trains, exclusive of engine and tender, 846·4 tons; average load of coal in trains, 666·6 tons; coal used per mile, 121 pounds, equal 0·97 pounds per car per mile; average life of steel fire-boxes, 120,000 miles; average life of copper fire-boxes, 45,000 miles; average life of iron tubes, 138,000 miles: brass tubes under test were found to be so unsatisfactory that they were abandoned.

Mr. McDonnell shows that iron tubes were used on the Great Western Railway of England; that the average life was 180,672 miles run. This makes ten years as the life; taking 17,500 miles as the yearly average of the engines, one engine on this railway ran 447,000 miles without the tubes being taken out.

Sir John Hawkshaw said, "He began the use of iron tubes as far back as 1834. It might be interesting to locomotive men to know that in the United States brass tubes were not now used, nor were copper fire-boxes. All the fire-boxes in the United States were of steel, and the tubes were of iron. From what he had seen and heard in America he thought it worth while for locomotive engineers to consider whether steel fire-boxes and iron tubes would not be cheaper and better than copper fire-boxes and brass tubes. His own opinion was that the change would be an improvement."

NOTE.—The life of steel and copper fire-boxes on the Reading Railway is given merely to show the difference. The life in either case is short in train miles, but might show by comparison with other roads very differently if car miles were used, as the coal trains of this railway are, for summer traffic, made up with 125 cars in each, and 115 for winter traffic, the coal carried for years averaging over 524 gross tons in each train.

Sir Charles A. Hartley, in his paper, No. 1,413, read before the Institution of Civil Engineers in 1875, on the Public Works of the United States, deals in many complimentary terms with what he saw. He describes the immense business of the Reading Railway, and says that the coal is carried 95 miles for 30 cents per ton, equal to $\frac{1}{6}$ of a penny per ton per mile.

For the benefit of the *professional man*, let us quote a few more scraps from the paper of Mr. Colburn, "the engineer of *considerable eminence*," and the discussion on it at the Institution of Civil Engineers in London.

Mr. Hemans said, "He disapproved of the stereotyped make of English locomotives and rolling-stock, and of the enormous weight placed on one pair of wheels, as great in some instances as 18 tons. These weights were very injurious to the permanent-way."

Mr. W. B. Adams said, "The frictions of the railway carriage were induced by the cone on the wheels; that loaded trains had stuck on inclines of 1 in 75, and single cars had stuck on 1 in 80, the friction being changed from the normal 8 pounds (as generally allowed for in England) to 28 pounds per ton."

Mr. G. Berkley said, "He was surprised to find that the weight of their wrought-iron wheels was greater than that of the cast-iron in the proportion of 6 to 5, while the cost of the English wheel to the American was as 4 to 2½."

Mr. Bridges, of the Grand Trunk Railway, wrote: "Our experience in the cast-iron wheels is that we consider them far superior to any wrought-iron wheels that have ever been imported from England. Several hundreds of cast-iron wheels imported from Glasgow were found to be utterly useless."

Mr. R. P. Hodge said, "He had tried the American oil-tight box on the London and North Western Railway; that a set of four had run 21,800 miles with one pint of oil, which oil was taken from the lower chambers, the dirt precipitated, and put back, when they ran the same distance over again. Whatever may be said of American railways, it should not be forgotten that some of the best railways of that country were constructed at a less cost than was paid for the engineering expenses alone of the Great Western of England."

Mr. W. Atkinson said, "He had visited the States and found the frictional resistances of engine-tender and cars was 4½ lbs. per ton. . . . The cast-iron wheels, the bogie frame, and the large one-compartment cars, had their origin in the extreme rigour of the American climate; the permanent-way was frozen so hard that the English composite wheel was shaken to pieces, and nothing but the cast-iron wheel could resist the rigidity of the road.

Mr. E. A. Cooper said, "He had made experiments with the American oil-tight boxes on the South-Western Railway; that in one case a force of 2 lb. per ton was sufficient to keep a car in motion; that at a speed of 15 miles an hour; the friction was 2·4 lbs. per ton, and at a speed of 25 miles an hour it was 2·8 lbs. per ton. The carriages had been tried in various ways: on a level, on inclines, and with and against the wind; the results had been proved in several ways. The experiments were made with ordinary carriages: one carriage, he was informed, had been run 9,323 miles with one pint of oil; the brasses lost one ounce in running 10,040 miles, and after 106,000 miles they were still in fair order. The friction of 8 lbs. per ton, which was common with ordinary grease-boxes, ought therefore to become a thing of the past."

Captain (now *Sir H. W.*) *Tyler, Royal Engineer*, said, "The adoption of the bogie and cast-iron wheels under all the engines, carriages, and wagons in America was an interesting subject of inquiry. It could not be from the sharp curves, for the curves, as far as he had seen on many lines, were not sharper, as a general rule, than they were in England. Certain engines sent to Canada, of the ordinary 6-wheeled coupled pattern of England, would not remain on the rails, even where there were no sharp curves. Those engines were altered; bogies were put under the leading ends, and they had since done good service.

Mr. W. Lloyd said, "He had invariably found great economy in the consumption of fuel in the English engines, and that American engines burned 18 per cent. more fuel than English, as proved by the experiments of Mr. Evans."

NOTE.—I beg to correct Mr. Lloyd in his remarks. Mr. Lloyd was never connected with any railway on which there was an American engine, nor had he ever any personal knowledge of the economy or want of economy of American engines. And he is in error as regards the 18 per cent. economy spoken of above, for, in the experiments he alludes to, there was, in one case, 19 per cent. economy in favour of the American engine, and, in the other case, 13 per cent. economy due to the English engine; but this would have been made more than *nil* if the consumption of fuel on account of speed had been equated; as the American engine, in this case, took the same train, on the same road, the same distance, at 42 per cent. greater speed.—W.W.E.

Mr. Colburn said, "There was evidence that English engineers and railway managers, on going to Canada to take charge of lines owned in England, had, notwithstanding their natural and habitual preference for English practice, adopted the peculiarities of the railway practice of the United States. These Anglo-Canadian engineers and managers asserted that the bogies drew more easily than carriages with rigidly-rectangular wheel-bases, and that chilled wheels were equally as safe as, and less expensive in maintenance than, wrought-iron wheels."

Mr. J. J. Berckel said, "In Canada the railways had been constructed by English engineers, and they had found it necessary to Americanize the whole of the rolling-strock. He knew for a certainty that the leading wheels of the engines sent out from England had been removed and replaced by bogies. . . . The explanation of the remarkable results of the author's experiments on train resistances must be sought, *he believed*, chiefly in the looseness of American railway construction. A train that ran on rails that yielded readily on its passage met with less resistance than if the rails were rigid."

NOTE.—This is "an opinion as is an opinion!" We in America never thought of this before. We must go to work and make our new lines more loose and the rails, sleepers, &c., more yielding. "There are millions in it," *if true*. This discovery displays almost as much engineering talent and deep investigation as was shown recently in the columns of the *Otago Times*, or *Australian Engineering News*, or the London *Engineer*, I forget which, when its brain worked out the astounding revelation that the *bar-frame* in the American locomotive was introduced to give it flexibility!

Mr. Berckel went on to say that he had once seen in England an engine, fresh from the erecting shop, that could barely start with 40 lb. of steam-pressure in the boiler, and this he attributes to very accurate fittings. Good Providence protect us from such accurate fittings; if the builder of this engine had gone a little deeper into accuracy he might have made a wonder of mechanism, one whose power to pull a train "no fellow could find out."—W.W.E.

Mr. O. Younghusband said, "The life of the chilled wheel made of Salisbury iron might be safely taken at 150,000 miles. There were some in Canada that had run 160,000 miles, and were still in good order." He then goes on to make