

present time a very strong tendency has set in to reduce everything to a standard, and although the Americans are keenly alive to all improvements, yet, as far as possible, it is attempted to reduce every detail down to a standard form; nor is this tendency confined to America, as for years past the various large companies in England have been concentrating their attention in the same direction. Mr. Wm. Stroudley, M.I.C.E., has developed a very interesting series of standard types of locomotives and carriages on the London, Brighton, and South Coast Railway, since 1870, when he was appointed locomotive superintendent of that line. Although there may be differences of opinion as to the types of engines adopted by Mr. Stroudley, there can be no question that the system of arranging the details of the several classes of engines, so that all the principal parts would be interchangeable, was a sound one, and one that if strictly carried out must lead to the most economical results, both in construction and maintenance. Another advantage in connection with the recent stock on this line, is that the whole has been constructed in the company's own shops to their standard templates, thus enabling all repairs and renewals to be rapidly and economically carried out.

The carriages on this line are of a very neat pattern, and, being made to a uniform design, have a very good appearance. This is especially the case with the close-coupled suburban train working the London metropolitan traffic; in point of fact, these trains are, as it were, one long, articulate carriage. They run with great steadiness, and were a great improvement on the mixed lot of carriages of various types previously in use on this line. The central buffer and draw-gear is very ingenious, and enables the train to pass round sharp curves with great ease. The London and North-Western Railway have also carried out the system of building their stock to a uniform pattern, and their trains have a very neat appearance, whilst, under the able management of Mr. Webb and his talented predecessor, Mr. Ramsbotham, the full advantage has been taken of the use of standards, and the rolling stock is constructed and maintained at a figure that would be much exceeded if it was not for the excellent system adopted. This

company manufacture the whole of their stock in their own workshops.

Although in England the individual railway companies have, to a large extent, adopted standards of their own, yet the standards of no two companies agree. Thus, if we take the three great companies running to the north, out of London, we find each has their own type of engines and carriages, and although each has the same class of traffic to deal with, we find engines of entirely different types in use. On the Great Northern Railway, the engines used for fast traffic have outside cylinders 18 in. in diameter by 28-in. stroke, and single driving wheels 8 ft. in diameter, while the front end of the engine is carried on a four-wheeled bogie. On the London and North-Western Railway, until recently, the heavy express traffic was worked with four coupled engines, with inside cylinders 17 in. in diameter, with 24 in. stroke, and 5 ft. 6 in. wheels. Webb's patent compound engines are now coming into use on that line. On the Midland the express traffic has been worked with four coupled engines, with 7 ft. wheel and cylinders 18 in. diameter and 26 in. stroke, with a four-wheeled bogie in front. It is interesting to note from the above how widely different classes of engines can be made to perform the same duty, and it may, therefore, be concluded that within comparatively wide limits the question of economy of working depends more on the adoption of a good series of standard types than upon minor questions of detail. About five different classes of engines are probably the largest number that there would be any justification in adopting on any railway, namely, fast and heavy passenger engines, fast and heavy goods engines, and tank engines for shunting and suburban work. Even this number might be reduced by making the fast goods engines do the heavy passenger work. With a well designed set of standard details, the principal parts of all these classes of engines could be made interchangeable, thus enormously reducing the number of templates and patterns necessary to keep in stock, and thus increase the facilities and economy of repairs and renewals. Looking at the question from an engineering point of view, there can be no doubt

that if all locomotives used on any one system of lines were manufactured in the company's own works, to their own standard templets, under skilful management, it would be far more economical than having them manufactured by half-a-dozen different locomotive builders, with more or less difference in their templets, even if the first cost was somewhat higher. When we come to State railways the question of the policy of the State employing additional labour and competing with private enterprise has to be considered, but this is a question for the politician and not for the engineer.

Having thus briefly considered what has been done in England in the way of standards, it may be interesting to see what is being done in this matter in America. We have seen that in England the various companies have, in a more or less perfect way, adopted standards of their own, but the tendency of modern American practice is to adopt a far more universal system of standards. This is even more important than in England, for with the vast extent of railways in America, owned by a large number of different companies, having an enormous through traffic, necessitating stock of one company travelling over the lines of perhaps a dozen different companies, it is evident that if the various details of car or waggon stock could all be made to one system of standards, any repairs that might be necessary to stock belonging to any outside company, could be quickly executed, and the value of such repairs easily assessed in accordance with such standards.

The Master Car-builders' Association of America have taken up the question of standards with great energy, and at their annual conventions, committees are appointed to consider various details and submit reports recommending the addition of standards to be considered at the subsequent annual convention. Already a large number of standards have been adopted by the Association, and are fast coming into general use.

It may be interesting to note with what care these committees examine the different matters submitted to them, and their action with reference to the adoption of a standard automatic car-coupler

is a good illustration. The importance of providing a good automatic coupling for waggon stock cannot be better illustrated than by giving the statistics of the number of shunters killed, and injured on the English railways. In 1884, 130 men were killed and 1,305 injured, whilst engaged in shunting operations, and during the previous nine years 1,122 have been killed, and 11,314 injured under similar circumstances.

The adoption of the standard automatic coupling is thus referred to in the *Railway Gazette*, of New York, in their issue of April 2nd, 1888 :—"It is now open to all to replace their relics of barbarism with the best devices that the joint labour of some 4,000 inventors, and an unknown number of railroad officers and men in the mechanical and other departments, have been able to produce. The M.C.B. type is the result of a rigorous process of endless tests, trials, and experiments, practical and otherwise, which have at last resulted in the 'survival of the fittest.'" This standard coupling is now being rapidly introduced, one firm making over 4,000 sets during the first three months of last year, and when this automatic coupling is extensively used, there will, no doubt, be a great saving of life. Anyone examining the primitive slack chain couplings used on English waggon stock cannot but consider that it is altogether behind the age, and, in the interests of humanity, it is to be hoped that the day is not far distant when these relics of barbarism will be things of the past. The side buffers and screw couplings in use on the English lines, and the broad gauge line in these colonies, although answering well on comparatively straight roads, by no means comply with an ideal system of connections for trains passing over sharp curves, and it would be a very interesting investigation to determine what proportion of the cost of repairs to carriage and waggon stock could be traced to the undue cross strains brought to bear on the under frames by the grinding action of the side buffers when passing round sharp curves. Anyone who has stood on the platform of the American cars fitted with side buffers in use in this colony, could not but be impressed with the severe side strains brought into play when the cars are passing round some of

our sharp curves compared with the ease with which our tramcars take the exceedingly sharp curves on the tram line, illustrating very forcibly the advantage of couplings designed in accordance with sound mechanical principles to meet a special case.

The same care has been exercised in the adoption of the other standards by the M.C.B. Association, and already a very large number of details have been added to their list of standards, including wheels, axles, axle boxes, draw gear, etc., and the beneficial results that must follow from the extension of the standard system cannot be over-estimated from an economical point of view.

Within the last few years it has become universally admitted that continuous automatic brakes are a necessity for the safe working of fast passenger trains, and their use is becoming universal on all first-class lines, and also that of the many forms of brake that have been tried, the survival of the fittest has now resolved itself into the automatic pressure and the automatic vacuum brakes, and there are many firm advocates of both systems. Both brakes are efficient, and each has its individual advantages; but as the brake question has been very fully discussed by this Association, as far as its application to passenger stock is concerned, it is not intended to go into it further to-night.

The question of applying a continuous brake to goods trains is one that is daily becoming more important, and a brief reference to this part of the subject may be of interest. The first extensive trials with power brakes were carried out by the M.C.B. Association in July, 1886. The result of these trials is given in a very elaborate report, published by the M.C.B. Association, but, as stated in the report: "The results of these 1886 tests were disappointing . . . owing to the violent shocks produced in stopping." The result of the 1886 tests showed that it was necessary for the train to be close coupled, and for the brake to act practically instantaneously on every vehicle of the train if the difficulty of violent shocks was to be got over.

In May, 1887, a fresh series of tests were made, when most of the brakes were fitted with an electrical device, to secure instan-

taneous action, and the Janney couplers were used instead of the slack links. The results of these trials were more satisfactory, but showed that the freight car brake was a long way from perfect. Since these trials, Mr. Westinghouse has invented a new form of triple valve, by which he has secured a practically instantaneous brake, the time taken to apply the brake on a train of fifty American freight cars, of a total length of about 1,900 feet, being only two seconds, no electrical device being used. Numerous tests have been made with this improved form of Westinghouse brake, with most satisfactory results, trains of fifty American freight cars being brought to rest, from a speed of thirty-seven miles an hour, in the exceedingly short space of 583 feet.

From the knowledge obtained from these trials, it may be concluded that, for long freight trains, it is absolutely necessary that they should be close coupled, and that the brakes should act practically instantaneously on every vehicle, to prevent the crowding up of the rear portion of the train, and at the present time the only automatic brake that fulfils this condition in anything like a satisfactory way, without the introduction of complicated electrical devices, is the new, quick-acting Westinghouse brake, neither the ordinary automatic Westinghouse brake or the automatic vacuum being sufficiently quick in action to prevent violent shocks when used for emergency stops with long freight trains.

The day cannot be far distant when the use of the automatic continuous brake will be as common on goods trains as they are on passenger trains, this is especially the case on lines with steep grades, as it is well known that the load a driver can take depends in many instances entirely upon the extent of the brake-power at his disposal. With an efficient continuous brake he would have the maximum supply of this power, and could consequently take a much heavier load than it would be possible for him under other circumstances to control on descending inclines.

Many other interesting points might be considered if time permitted, but from the foregoing the following conclusions may be drawn :

Firstly, that as far as the permanent way is concerned, the adoption of light rails, when by any possibility heavy rails can be afforded, would be a very great mistake from an economical point of view. Secondly, that when good hardwood sleepers can be obtained at a reasonable cost a T road with angled fish-plates and a few extra sleepers will be more economical than a chair road with sleepers further apart. Thirdly, that points, crossings, and connections should be made to fixed series of standards, with as few different sizes as possible.

As regards rolling stock :—

That engine, carriage and waggon stock should be made to a fixed series of standard patterns and templets, reducing the number of types to a minimum, and that perfection is more likely to be approached by a careful study of the works of others and a sifting of the vast experience gained by the innumerable experiments tried at various times throughout the world, and the adoption of what has proved successful, than by attempting to launch out into a new field of our own.

Whilst the author is by no means prepared to say that the days of invention are passed, yet before attempting to invent it may be more profitable to fully digest what has already been done and so obtain a new point of departure, than to start on our own account and perhaps traverse ground that has many times been trodden before, and probably find as a result of our labours that some one has obtained much better results years ago.

In engineering matters connected with railways there can be but little doubt that the true road to successful operations and economy is first to devise a good system of standards, and then to see that the system is faithfully carried out, and this is undoubtedly the tendency of modern railway practice.