Railway Accidents; their Cause, and Means of Prevention. By Captain
MARK HUISH, Assoc. Inst. C. E. Edited by Charles Manby, M. Inst.
C. E., Secretary.*

In entering upon the subject of this paper, it is unnecessary to occupy time in demonstrating the fact, that compared with its results, whether as regards the ease and celerity of transit, or the facility of conveying numbers, railway traveling, even in its present state, is incomparably safer than any previously designed system of locomotion.

Contrasting the mere numbers transported from one locality to another, in the present day, by railways, with those conveyed by coaches during their most active period, the ratio of safety is indubitably in favor of the former; while if the difference of speed is imported into the consideration, the value of the immunity from accident, in the case of railways, is considerably enhanced. Even at the present time, when railway traveling has superseded all other modes of inland communication, it is doubtful whether the contingencies attending conveyance by horses in this kingdom, embracing in that category the omnibus traffic, do not annually exceed in amount the casualties on railways, and it has even been asserted, on apparently sufficient data, that the accidents to pedestrians in a given period would still leave railway managers in a position to point with satisfaction to the superiority of their system, on the score of safety.

The attention which has latterly been paid to the statistics of railways, and the periodical publication of the Government returns, direct public attention very pointedly to the aggregate of accident, in a manner which has not been attempted in any other department, and tend to fix a degree of responsibility, and to cast an amount of odium, which have not attached to less prominent and perhaps less useful adaptations of science and discovery. Were the casualties to steamboats as carefully chronicled, and the deaths in mining as elaborately tabulated, or were even the fact of a British vessel being wrecked on each tide throughout the year, as generally known, the public would view more justly the occurrence under the railway system, of those contingencies, which, even under the most perfect management, must ever accompany the arrangements of fallible man; while, however, it is pleaded in behalf of one of the greatest inventions of the nineteenth century, that due regard must be had to comparative results; and while it cannot be denied, that but little consideration has been exhibited, either by the public, or the press, and still less sympathy been shown, during the difficulties under which the railways of Great Britain have struggled into their present position, it is not contended, either that the system has yet attained the degree of perfection and consequent safety of which it is susceptible, or that it has in all cases been administered in the most judicious manner.

Experience is daily adding to the knowledge of the dangers which in an infinite variety of occult forms, necessarily attach to the momentum of high speeds, and this experience is constantly suggesting fresh precautions and means of prevention. To detail as briefly as possible some of the prominent causes of accident, and to explain the measures adopted

* Proc. Inst. Civ. Eng., April 27th, 1852.—London Railway Journal, No. 700.

for securing the safety of the public (the paramount and primary duty of railway management), is the subject of the present paper.

Without further preliminary remark, therefore, the first point of interest is the road, and the contingencies connected with it, embracing the very important subject of the permanent way.

A firm, substantial, and well kept road is undoubtedly the basis of all safety in railway traveling, and with the heavy and increasing traffic now passing over the iron highways of Great Britain, it requires the most incessant vigilance (especially since the speed of the trains has been increased) to maintain the way in the condition which is essential for the safety of the passengers and the economy of the rolling stock. As the intervals between trains become less frequent, as the speed of traveling is accelerated, and as the heavy merchandise traffic, which promises to form, ere long, the most important feature in the receipts of many lines, increases, the repairs become greater, and at the same time more difficult to carry on. It is not intended in these brief remarks, to enter on the very extensive field of "permanent way," especially as it is a subject so familiar to the members of the society, but the experience of the author leads him to the conclusion, that even more attention than has hitherto been given to this fundamental question, must be devoted to it in future, or the theories which have been constructed, and the practice based upon them, will be found to fail. Improvements are continually introduced for the purpose of obtaining a sound continuous road, and there is no doubt that the recognised evils will eventually point out their own remedy. Fishing the rails is now a popular and, as far as partial experience can determine, an efficient mode of strengthening a railway, for the increased traffic it has to bear. Other measures, having the same object in view, are in course of experiment, and stone blocks are generally being rejected in favor of wooden sleepers. Heavier rails, with shorter bearings, are gradually being introduced wherever relaying has become necessary, and engineers are fully sensible that a road constructed to support moderate trains, drawn by light engines at low speeds, is utterly inadequate to endure the crushing effects of monster locomotives at express speeds. The defects of lamination, deflexion, and splitting of the rails are rapidly increasing; whilst transverse fractures (a species of failure almost unknown a few years ago) are now of frequent occurrence; and the difficulty of maintaining the gauge of the line, under the present weights, not only increases, but much of the oscillating motion which is so unpleasant to the traveler, and so destructive to the stock employed, must be attributed to the same cause. Requiring, as railways do, superior rails to bear the increased strain now thrown upon them, it is painful to observe that, instead of keeping pace with the necessities of the case, the rail-makers have allowed their production to deteriorate very greatly; indeed, the utmost caution is now required in the purchase of rails: with every security afforded by name and standing in the trade, the greatest disappointments are daily arising, and the result promises to be very serious, unless instant measures are adopted by the principal makers, to retrieve their characters in this respect. Many of the rails recently supplied have shown symptoms of failure at an unusually early period, and are, in many instances, in a worse condi-

tion, after two or three years' wear, than old and much lighter rails which have been subjected to precisely the same duty for twelve to sixteen years. So grave has the aspect of this matter become, and so general has been the complaint, that one railway Company has come to the determination of rolling its own rails, and has given instructions for erecting works for the purpose. Under all the disadvantages, however, to which allusion has been made, it is, after all, remarkable how very few accidents have arisen from a defective state of the road itself. The circumstance of a train running off the line is very rare, and when such an event does occur, it may generally be attributed to some palpable neglect of the platelayers, to some defect in the machinery, or to some obstructions designedly placed on the line. The latter is unhappily a very fertile source of danger, and one against which, where a morbid desire to inflict injury guides the miscreant hand, it is very difficult indeed to guard. It is little known how frequent, how ingenious, and how varied these attempts have become, and although, from the vigilance exercised, and from fortunate and providential causes, the real damage effected has been far less than could have been supposed, it is lamentable to think, that in addition to the ordinary risks of rapid locomotion, it should be necessary to guard continually against so diabolical a mode of wreaking a petty vengeance, or of gratifying a mischievous disposition. Numerous instances might be given which would excite surprise from the cunning design exhibited, and the care apparently exercised in selecting a spot likely to be fraught with the greatest amount of mischief; but the detail would occupy too much space. One only, and that the latest attempt of this kind, may be mentioned:—A few weeks ago, upon a branch line in Lancashire, the points of an important siding were jammed open, and in order to prevent the signal-man from averting the intended accident, the wire of the auxiliary signal was lashed with a piece of string, and was thus prevented from acting. Happily, however, by a fortuitous circumstance, the villany was discovered a few minutes before the passenger train approached. It has been customary, when such attempts have been made, to offer a considerable reward for the discovery of the perpetrators. It is questionable, however, whether setting a patient watch, and establishing a careful inquiry throughout the neighborhood, are not more effectual means of tracing the culprit. Considerable success has certainly attended this course, while there is, it is believed, no instance of a voluntary statement for the purpose of securing the reward. The punishment for this class of offences has recently been made more severe, and although it is not to be expected that they should altogether cease, it is hoped that they may become less frequent.

The alternations of weather in a climate so variable as England, have a material influence on the permanent way, and on any great and sudden change, either to heavy rain, after lengthened drought, or to a rapid thaw, after continued frost, increased watchfulness is necessary on the part of the upholders of the road, and the engine-drivers and guards. It is at such periods that the weak points in a road show themselves; a sudden relaxation of the line seems at once to take place, and unless counteracted by vigilant attention, great danger must result.

The rapid development of general traffic on all the main arterial lines

in the kingdom, and the transfer to them of much of the heavy trade which was formerly carried on by canals, have caused a very great extension of siding accommodation, and this, by multiplying the points and crossings in the main line, has *pro tanto* increased the risk attending them. Anything which breaks the continuity of the rails is necessarily an evil, and tends in a certain degree to develop danger; and as these frequent "turns out" cannot be avoided on a line of heavy traffic, the railway manager is compelled to rely on regulations and signals, and to that extent is obliged to incur the additional hazard which attends the employment of officials, from whose neglect, or want of discretion, the most fatal consequences may at any moment arise. On the London and North Western Railway, the increase of siding, during the last few years, amounts to 53 miles. In laying down these sidings, one very fertile source of danger has, however, been considerably reduced. "Facing points" were formerly common and numerous, they are now rarer, and although at the junctions of branches, and in some peculiar positions, they cannot be altogether abolished, no railway manager will rest contented while one of these points is allowed, unnecessarily, to remain upon his line.

In connexion with this subject, allusion may be made to self-acting switches. Useful as this invention has proved, it has been attended with concomitant evils of no trifling magnitude, and many accidents have occurred from a reliance upon them. They require constant vigilance to secure their being kept clean and well oiled, and it is very difficult to insure proper attention being always paid to them. It may indeed be remarked, as a general rule, that so far from machinery being a means of safety (when used for superseding personal inspection and manipulation), it is usually a source of increased danger, and the numerous clever contrivances and complicated arrangements which are so continually submitted to the examination and opinion of railway men, though evidencing the ingenuity and industry of the projectors, are generally valueless as practical means of operation. The greatest simplicity in every thing connected with the road and the signals upon it will provide the nearest approach to security, and in proportion as such simplicity is departed from, it is probable that a practical good will be sacrificed, in endeavoring to attain a theoretic excellence. In concluding this branch of the subject, it may be repeated, that fewer accidents to life and property arise from the road than from any other cause, and were casualties confined to those attributable to "the way," the annals of railway accidents would be scanty in the extreme.

The next question of interest is the "locomotive"—that extraordinary invention, which has already changed and ameliorated the whole surface of society, and which is destined to work still greater revolutions in the social fabric of the world. The increased power and capacity, the more perfect finish of the various working parts of the engine, and the general improvements in form and proportions, which have been gradually introduced, have rendered far less frequent than heretofore, those delays and irregularities which are always attended with inconvenience, if not with danger; yet it would be too much to expect immunity from casualties to so elaborate and so severely tested a machine, and though the

parts have been greatly strengthened in every respect, the improvement does not appear to more than meet the greater demands on its powers, in consequence of the increased loads and speeds which are now adopted.

The variety of mishaps to which a locomotive is liable will be seen from the following table, containing the causes of one thousand failures on the London and North Western Railway.

This return spreads over a lengthened period, comprises every description of defect, and is given for the purpose of proportion only.

ANALYSIS of 1000 cases of engine failures and defects, occurring on the London and North Western and subsidiary Railways.

STOCK OF ENGINES, 587.

157 Burst and leaky tubes.	904 Brought forward.
92 Broken springs.	7 Broken blow-off and other cocks.
89 Broken valve-spindles.	6 Broken quadrant studs.
77 Broken and defective pumps.	6 Lost and loose regulator spindles.
48 Broken feed pipes.	6 Broken gibs.
40 Broken piston rods and pistons.	5 Broken stay in fire boxes.
34 Broken and damaged valves and valvular apparatus.	5 Detached ash-pans.
34 Lost and broken bolts and pins, (various.)	3 Smoke box and chimney end on fire.
34 Fire bars burnt out.	3 Broken brackets of weigh bar shafts.
31 Lost and broken cotters, (various.)	3 Feed pipes stopped up, dropped fire.
29 Plugs and joints blown out.	3 Broken spring balances.
25 Broken and lost eccentric straps.	3 Broken slide blocks.
21 Broken wheels and tyres.	3 Broken crank rods.
21 Broken and bent coupling and connecting rods.	3 Tubes drawn in (Chimney end.)
17 Broken sponge boxes.	3 Broken axle boxes.
17 Broken and bent eccentric rods.	3 Broken slide valves.
17 Broken crank pipes.	3 Broken right hand bearings.
15 Broken and shifted eccentric shafts.	3 Broken glands.
15 Broken coupling and draw bars.	3 Defective hose pipes.
13 Broken crank and other axles.	3 Broken piston rings.
13 Broken eccentric straps and bolts.	2 Broken brakes.
13 Broken and damaged steam and suction pipes.	2 Lost quadrant washers.
13 Broken and defective reversing levers.	2 Broken goss head spindles.
11 Broken connecting rod straps.	2 Mud-hole doors defective.
11 Broken middle bearings.	2 Broken weigh bars shafts.
9 Broken spring bearings, screws and buckles.	2 Broken brasses of driving journals.
8 Broken lifting links.	2 Broken studs of link motion.
	2 Broken catches of fire bars.
	2 Broken glass tubes.
	1 Nut off tender draw-bar.
	1 Broken tender eye bolt.
	1 Defective whistle.
	1 Boiler burst.
904 Carried forward.	1000 Gross total.

It would be interesting to know how far this return coincides with the results on other railways, because, were somewhat similar ratios evolved, the knowledge of the proportions would direct the special attention of locomotive superintendents to the necessity of guarding more particularly against casualties of most frequent occurrence. It will be observed that burst and leaky tubes nearly double any other class of failure, and that these with broken springs and broken valves amount to one-third of the entire number. Very few, indeed, of the above failures are attended with any direct danger to the public, but as producing a temporary, or permanent inability of the engine to carry on its train, may be the remote cause of collision.

The carriage stock of railway Companies is generally of so superior a kind, both as to design and construction, that accidents arising from their failure are very rare. The wheels and axle-boxes are the most severely tested parts of the vehicle, but if originally of a proper construction, give very little trouble in their maintenance and repair. Experience seems to give the superiority to the wooden wheels, of which there are many kinds in use. A spring sometimes breaks, and a tyre occasionally fails, in which case the wheel is in danger of flying to pieces, but the instances are so unfrequent, that they are not sources of much anxiety to a railway manager. Defective workmanship, where either the carriage, or the principal parts of it, are supplied by contract, has specially to be guarded against; where these are sound and the carriage is daily examined, it may be relied on for a very long period. During the last four years, only six wheels have failed, in the very large stock of the London and North Western Company. The heating of axles, however, is a source of frequent annoyance and alarm to passengers. Since the bearings were increased in size, and more care has been exercised to make the cover fit close, and to preserve the grease free from dust, when not in use, this cause of trouble has diminished, and the recent introduction of the patent axle-box, which, under proper management, will run many hundreds of miles without being fed, bids fair to obviate the evil to a considerable extent, if not to prevent it altogether; still, on a hot summer's day, in a district with sandy ballast, it is, and will always be, very difficult to keep the axles of a fast train cool. The couplings of carriages are seldom broken, even by sudden jerks.

There is, perhaps, no more alarming occurrence than a fire in a passenger train. Still, however, there has not been an instance in this country of any loss of life from this cause, nor have the cases been numerous; but there have been several narrow escapes, and the accident is one to which a train may be at any instant subject from the escape of heated coke. Spontaneous combustion has also in more than one instance nearly produced a serious conflagration. This has arisen from the incautious introduction of lucifer matches, or similar combustibles, among the luggage of the passengers. The occurrence of fire, and the feeling of insecurity which attaches to the passenger, from a feeling of inability to stop the train, if desired, from any other cause, is continually reproducing a multitude of schemes for communicating between the passenger and the guard, and the guard and the driver. These have assumed a multiplicity of forms, yet the principle is generally identical, viz: a connexion by wire, or rope, between the engine and the guard's van. Simple and inexpensive as this contrivance is, it fails in practice, and after being adopted more than once, has again been laid aside. The whole of the trains of a northern Company were some time back fitted with the means, by a flexible jointed tube, of communicating with the driver, but it has not been considered a successful attempt to overcome the difficulty. The same may be said of the numerous contrivances for arresting the passage of a train, by the instantaneous application of a number of powerful brakes, (some of the inventions applying the brake to the road itself;) of the proposals to work signals by means of the engine striking certain levers as it passes; and hundreds of similar suggestions. Among the

inventions transmitted to the author, and for most of which compensation was claimed, one proposed to arrange a set of signals, which were to be successively struck down by the chimney of the engine; and another, in order to stop a train in the shortest space, gravely proposed that a large anchor attached to a stout cable, should be thrown out of the stern! Perhaps the most feasible and favorite plan for giving confidence to passengers, has been to continue the foot-boards of carriages, so as to form a continuous narrow platform, with a brass rod attached to the panel of the carriages; by this means a passenger might escape and pass safely along to the guard's van, or to the engine. The plan was suggested to and recommended by the Railway Commissioners. A committee, of the most experienced railway officers, was appointed by the clearing-house to consider it; they have done so, and their report, founded on returns and reasonings, which appear unanswerable, is the unanimous condemnation of the measure. We are thus apparently as far off as ever from gratifying the public demand for instant communication between the passenger and the guard, and it is possible that no better plan will be discovered, than that now in use on the London and North Western line. It is as follows:—The guard's van at the rear of the train, projects more than a foot beyond the carriage on either side. In this projection a glass window is fitted, the guard's covered seat being opposite to it. He is thus enabled to see the entire length of the train, and can scarcely fail to observe a hand, or a handkerchief, if waved from a window. This contrivance is evidently unavailing at night, unless a spare light were by some means placed at the disposal of the passenger. At present, however, it only to some extent meets an evil, for which no more practical and complete cure has yet been provided. The almost universal practice of leaving the doors at one side unlocked, is a source of not unfrequent accident; yet so distasteful in public opinion is a locked door, that only one Company has ventured to adopt it as a rule. The reckless conduct of many habitual travelers may yet possibly force it as a regulation on others, especially if juries continue to inflict severe punishment on Companies, even when the fault is primarily with the passenger himself.

If, however, there is no part of the railway machinery from which so little danger may be apprehended as the passenger carriage, the same cannot be claimed on the part of the merchandise wagon. Whether the absence of direct danger to human life, or an injudicious economy, has been the cause, the fact is, that in no portion of the system has so little improvement been exhibited, and in which, at the present moment, there is so great a necessity for a complete modification. In this respect England is far behind the Continent. The axles of wagon stock have, in many instances, been of the most faulty model and material. The accidents to the trains, from the fracture of these parts, have been very numerous, while the destruction of property has been sufficient to have paid for a very superior vehicle. In one recent instance, several hundred axles, of a peculiar form, were removed from a leading railway, after a short experience of their working. Axles are now made much stronger than formerly; $3\frac{1}{2}$ inches used to be the ordinary diameter, 4 inches is now considered a minimum, and although more attention has been bestowed on the form and taper of the axle itself, still very much remains

to be done in this matter. The fact of the crystallization of the iron by the repeated vibrations, and the peculiar causes of incipient fractures, are still debatable points with engineers and wagon builders. It is desirable that by a thorough examination of the subject, these disputed questions should be disposed of. The wrought iron wheels of merchandise wagons do not on the whole give much trouble. The most defective part of the wagon is, however, the mode of coupling. This is of the rudest kind, and it is matter of surprise that a vigorous and combined effort has not been made by the railway interest to improve it. Very few merchandise wagons have spring buffers, and even those that have them, are simply linked together by a loose chain. Every one must have noticed the bumping sound produced in the starting and stopping of a merchandise train. Even where the driver is very careful, the succession of heavy blows in a long train is sufficient to injure the stock, and to break any delicate articles that may be conveyed in the trucks; but when it becomes necessary to arrest a train suddenly, the shocks are very destructive to the framework. This evil, great as it is, is aggravated by the circumstance of a variety of wagons being run in the same train; a light and short wagon is probably found between two long and heavy ones, and the irregularity of loading, according to the staple trade of a particular district, still further increases the risk. From the through system of traffic, the wagons of half a dozen Companies may frequently be found in one train, and as these are not built to any particular height or breadth, the ends do not strike evenly, and on receiving a check, a tendency to mount (especially if the wagon is unevenly loaded, which must always be the case with some description of goods) is apparent. Covered vans, low timber trucks, and box-wagons, are all run together, in trains of from 30 to 60 vehicles, and at speeds varying from 15 miles to 20 miles an hour. It is, in fact, a wonder that a traffic so conducted is not subject to continual accident, and the circumstance of the comparative freedom from casualty is rather an evidence of the extreme safety of transit over parallel iron bars, than any defence of a system which is no credit to the mechanical skill of the country. Until every wagon is coupled up to spring buffers, in the same manner as a passenger carriage, and until either by general concert, or by compulsory regulation, the standard central height, and central breadth between the buffers, are matter of regulation, the risk of accident and the certainty of damage must continue. The author succeeded, some years ago, in obtaining, through the medium of the railway board, a general concurrence on the subject of the buffers of passenger carriages, but no measures have yet been effectual as regards merchandise vehicles.

Fires in merchandise trains are of frequent occurrence, and from the susceptibility of the tarpaulin covering to ignite, and the presence of straw in the loading, considerable danger must always exist. This fact and the damage which fine goods receive from wet, have caused the introduction of covered wagons. The use of these wagons is now greatly increasing, and for all goods capable of being closely packed, they bid fair to entirely supersede the open truck and tarpaulin. The first cost is greater, but the repairs of the sheets, in three or four years, will fully compensate for the difference.

(To be Continued.)