LONDON AND NORTH EASTERN RAILWAY.

MINISTRY OF TRANSPORT,
Metropole Buildings,
Northumberland Avenue,
London, W.C.2.
13th July, 1937.

SIR,

I have the honour to report, for the information of the Minister of Transport, in accordance with the Order of 16th February, 1937, the result of my Inquiry into the circumstances of the accident which occurred about 12.45 p.m. on 15th February at Sleaford North Junction, on the Lincoln-Spalding line of the London and North Eastern Railway.

As the 10.25 a.m. express passenger train, York to Lowestoft, was traversing the junction, it became derailed and the three leading coaches, having broken away from the engine, were diverted to the left and fell over; by an unlucky chance a platelayer's hut, in which five platelayers were having their dinner, was in the path of two of these coaches and was completely wrecked by them. I regret to state that three of the gang were killed and a fourth died in hospital that evening, while the fifth was seriously injured. There were a number of passengers in the train and, in view of the results of the derailment, it was fortunate that casualties among them were, comparatively speaking, trifling, being confined to 15 cases of minor injuries and shock.

The train consisted of ten coaches, all being 8-wheeled bogie vehicles with steel underframes and timber bodies; all coaches were fitted with the vacuum brake on all wheels and, except the seventh coach, all had Buckeye couplers. All had electric light; the seventh vehicle, a dining car, had gas for cooking. The total weight was 309 tons and the percentage of brake power was 70 per cent.

The train was drawn by engine No. 2829, type 4—6—0, with 6-wheeled tender, weighing 116 tons in working order. It was fitted with the steam brake, controlled by the vacuum, on coupled and tender wheels, and the percentage of brake power was 45 per cent.

After the derailment the engine ran forward for about 69 yards from the leading end of the first coach, and came to a stand with its bogie wheels on the rails; the coupled and tender wheels were derailed to the left, but close alongside and following the alignment of the rails.

The leading coach was lying on its left side down a low bank, parallel to the line, with its trailing bogie torn off. The trailing end of the second coach and the leading end of the third coach had apparently been forced out to the left by pressure from the vehicles in rear, and lay at about a right angle to one another, the second coach being on its side and the third tilted almost on to its side.

The fourth, fifth, and sixth coaches were derailed all wheels, but remained upright and approximately on the alignment of the track, and the last four coaches were not derailed or damaged.

The tender coupling was found, unbroken, attached to the leading coach; the leading link was twisted, and from the marks on the tender hook it was clear that this link had been pulled through the Gedge slot, suggesting that it must have been turned nearly into the vertical plane by the overturning of the coach before it became detached from the tender.

At the trailing end of the leading coach, the lock of the Buckeye coupling was displaced and the coupling was deformed. The coupling between the second and third coaches was broken, these coaches lying at right angles to one another. Other couplings on the train were unbroken.

A summary of damage to engine, coaches, and permanent way is given in the Appendix.

The weather at the time was fine with good visibility, and the rail was dry.

Description.

Approaching Sleaford North Junction from the North, the double track line is on low bank, lying approximately North and South, and is straight from beyond the up distant signal. At the junction the up and down avoiding lines continue on about the same alignment towards Spalding; these lines are normally used for goods trains only, but are described as the "Main Line." The double track lines to Sleaford Station curve away to the right and are termed the "Branch Line." There is a speed restriction of 20 m.p.h. through the junction on to the branch line; until the beginning of 1937 the restriction had been 15 m.p.h., but in the periodical review of all speed restrictions this was raised to 20 m.p.h., the curvature, cant, and track generally being considered suitable for this speed.

Sleaford North Junction signal box is immediately North of the junction, and a level crossing with gates controlled from the box is adjacent.

Distances from the signal box:—

Lincoln Station	about 18½	miles	North.
Up Distant (can only be pulled for main line)	1,006	yards	,,
Up Main and Branch Home signals ...	96	,,	,,
Level Crossing	25	,,	,,
Toe of facing points	8	,,	South.
First mark of derailment (on check rail at nose of crossing)	40	,,	,,
Centre of diamond crossing	60	,,	,,
Trailing end of sixth coach (last coach derailed)	80	,,	,,
Platelayers' Hut	140	,,	,,
Leading end of first coach	178	,,	,,
Trailing end of tender when engine came to a stand	247	,,	,,
Up Branch starting signal	463	,,	South-West.
Sleaford Station	about 2¼	miles	,,

Approaching the junction the gradient is rising at about 1 in 460 from beyond the up distant signal, and from the junction the branch line falls at 1 in 650 towards Sleaford.

The line from Lincoln is, generally speaking, level with moderate curvature, and speeds up to 70 m.p.h. are commonly attained by express trains thereon.

Report.

The train in question left Lincoln at 12.31 p.m., 8 minutes late; engine No. 2829 had been attached at Lincoln and was driven by Driver L. Green, who had been driving over this road since 1919 and was familiar with the train and the type of engine.

Green stated that he had a clear run as far as the Sleaford North Junction distant signal, which was against him as it cannot be pulled for the branch line. This train always travels by the branch line as it is booked to stop at Sleaford Station; up till a month previously Green had been working in a link in which he occasionally took a goods train down the avoiding line, but even in such cases he said that speed did not exceed about 20 m.p.h. through the junction, as the goods train had to stop at a water column some 1½ miles beyond.

He was running at normal speed, which he estimated at 50 to 55 m.p.h., until approaching the distant signal, when he closed the regulator before he got to the signal and made a gradual brake application, reducing speed to what he considered to be about 20 m.p.h. at the home signal. He stated that he then put the brake handle in the running position, but did not open his regulator as he was awaiting word from his fireman as to the aspect of the starting signal ahead, which would be first seen from the right-hand side of the footplate.

He was aware of nothing amiss until his engine was through the diamond and about opposite the platelayers' hut, when he heard a rattle from the tender and felt a bump, followed by other bumps, and realised that something must be off the road. He put his hand to the brake lever but as he did so saw the vacuum destroyed, felt the brake applied, and realised that a coupling must have parted.

He thought at the first bump that the tender was off the road, but after subsequent bumps realised that some of the engine wheels must be off also. He did not realise that all six coupled wheels were off until he got down on to the permanent way after stopping.

Fireman Goodge generally confirmed Driver Green's statements, as also did Driver Davies who was travelling on the footplate learning the road; he said that he was studying a diagram and watching the signals, and was in consequence not taking much notice of speed. He was satisfied, however, that there had been a substantial reduction of speed from the distant signal, and both men were of the opinion that the engine had passed over the diamond before they felt anything amiss.

Guard Tindall, who had worked over this road for five years, was travelling in the fifth coach and said that running was normal until passing the distant signal, when he noticed a brake application; he could not say whether the van valve operated, but the application was a moderate one. He looked out of the window on the left-hand side between the distant and home signals, noted that the speed was being reduced, and when passing the signal box considered that speed was not more than 20 m.p.h.

He was under the impression that the brake blocks were still rubbing when he felt a lurch to the left after passing the signal box, and the sudden stoppage occurred almost immediately after the first lurch.

Ticket Inspector Millington had been all through the train after leaving Lincoln, and said that all coaches were running all right. He was in the seventh coach (dining car) when he noticed the usual speed reduction approaching the junction. He could not say whether the brake was still applied when passing the signal box, nor did he notice passing through the junction prior to a sudden stop which seemed to have a sort of concertina effect.

Actually the seventh coach stopped over the south half of the diamond, and was not derailed.

Dining Car Conductor Moggridge was in the same coach. He stated that he knew the road well and that the dining car staff made a practice of warning one another when they came to this junction if they felt that speed was more than the average. On this occasion the train had been running smoothly at normal speeds, and they did not call out any warnings as the speed seemed reduced to normal. He did not feel going through the points at all, and the first thing he noticed was a grating sensation as if by a sudden brake application and a stop with some rough jerks.

Various members of the Company's staff were riding in the train as passengers; Mr. Parlett, Stationmaster, Rauceby, was in the fifth coach, Driver Temple, Fireman Thomas, and Guard Dowse were in the rear coach, and Driver Wright and Fireman Bailey were in the third coach. All of these gave evidence as to normal running from Lincoln, and a brake application at the distant signal reducing to a speed estimated at about 20 m.p.h.

Ganger Speed had been with the Company 44 years and employed as ganger for 36 years, the whole time on this length.

On the day of the accident he had been with his gang when they started work; they were on ordinary maintenance and started from about opposite the permanent way hut, working in a Northerly direction. The gang were packing under sleepers and had no renewals or replacements; the weather had been wet and there had been no trouble with keys coming out.

Speed stayed with the gang till about 9.15 a.m., when he started to walk his length in the Sleaford direction; he returned about 12 o'clock when the gang had just knocked off for dinner, and he went direct to his own house which was a short distance on the Sleaford side of the junction. He heard nothing of the accident till he came out to rejoin the gang, when coming round the curve he saw the derailed coaches.

Lengthman Edenbrow was dealing with signal lamps till about 10.0 a.m., when he joined the gang and remained with them till the dinner hour. He was emphatic that they were doing nothing more than packing, though they would, of course, have tightened any bolts had any been found to need tightening. There were no keys out nor any broken chairs. He thought that they had just got past the diamond when they ceased work. There was other evidence generally to the effect that they were working about the diamond or the junction at the dinner hour.

Careful inquiries were made as to the possibility of any tools having been left on the track as a possible cause of derailment, but all tools, including two track jacks, were found to be complete and in good order. Moreover, a goods train had passed on this track subsequent to the gang leaving work and immediately before the express.

Particulars of Locomotive.

Engine No. 2829 is of the three cylinder type, the leading coupled axle having a central crank for the drive from the inside cylinder, and the outside cylinders driving the intermediate coupled axle.

It was built at Darlington in 1931 and had run a total of about 234,000 miles. It had had general repairs in March, 1936, since which date it had run about 37,000 miles. As far as can be ascertained, none of the springs had been changed since that general repair, and the only shop repairs done had been due to the left leading bogie axle box running hot in December, 1936, when the journals were re-turned and the axle replaced. The running repairs booked for the last month do not indicate any unusual defects.

The drawing attached indicates general dimensions and designed axle weights, together with actual weights on individual wheels as weighed after the derailment, the engine having been hauled dead from Sleaford to Doncaster Works. The engine had been weighed and adjusted to diagram weights in June, 1936.

Springs of all coupled and tender axles are of the laminated type, the bogie having two coiled springs to each axle box; none of the springs was broken.

The weight of the leading end of the engine is carried on the bogie by a flat circular bearing plate and pivot, which is capable of lateral movement under the restraint of coiled springs in front and in rear. These side control springs have a free length of 16 inches; with the bogie in a central position they are compressed to 15 inches under a pressure of ·32 ton, and for the maximum designed lateral translation of 4 inches, the springs on one side being compressed from 15 to 11 inches, the pressure rises to 1·6 tons.

The actual vertical and lateral clearances of the bogie axle boxes showed no material discrepancy from the designed figures, and all bogie wheels were true to gauge with tyres of good profile, and no marks of damage or abrasion.

The leading coupled wheels were found to be $\frac{1}{16}$ inch wide to gauge at one point on their perimeter; this was apparently due to bending of the cranked axle, and it seems reasonably probable that it was a result of the derailment. The intermediate and trailing coupled wheels were true to gauge, and all six tyres were of good profile and showed comparatively little signs of wear; the intermediate coupled wheels had the British Standard thin flange.

Tyres of all six coupled wheels were considerably marked and indented; the derailment was to the left (the outside of the curve) and, as might be expected, the marks were mainly on the flanges of the left-hand wheels and on the treads of the right-hand wheels. Also, generally speaking, the indentations on the leading and intermediate wheels were more frequent and larger than those on the trailing wheels.

The designed vertical clearances of the coupled wheels are $1\frac{5}{8}$ in. above and $2\frac{3}{4}$ in. below the axle boxes; the actual clearances varied from $1\frac{1}{2}$ in. to $2\frac{1}{8}$ in. above and from $2\frac{7}{8}$ in. to $2\frac{1}{4}$ in. below. There were no marks to indicate that either top or bottom of the axle boxes had been in contact with the hornblocks or hornstays.

The actual lateral clearances were ·129 in. in the case of the leading axle, ·25 in. on the intermediate axle, and ·15 in. on the trailing axle.

The tender wheels were true to gauge and of good profile, and there was nothing abnormal about the vertical and lateral axle box clearances; no springs were broken. The tyres were practically free from marks either on flange or tread, and it would appear therefore that these wheels must have come off in the later stage of the derailment, and only a short distance before the engine came to a stand. This is confirmed by damage to the safety links coupling engine and tender, which are free to move laterally in slots in engine and tender framing; the right-hand link had been bent both laterally and vertically by contact with the end and the upper edge of the slot in the engine frame, in such a manner as to indicate that at some time the centre line of the engine footplate had been displaced some 6 in. laterally to the left of, and some 3 in. below, the tender footplate. This seems to be a very definite indication that at some period the engine coupled wheels were derailed to the left while the tender wheels were still on the rails, and that the latter were probably carrying some of the weight of the rear portion of the engine.

Apart from the damage to tyres and wheels noted above, the only damage on the engine was to the brake gear of the intermediate and trailing coupled wheels. The brake blocks are castings with two cheeks which lie outside the brake hanger and are secured thereto by a pin; in the case of the left intermediate coupled wheel, the cheek on the outside of the brake block was broken but all parts were still in position. This fracture might well have been due to a sudden lateral thrust from the tyre on to the brake block.

The brake block of the left trailing coupled wheel was missing and could not be found among the debris. The pin, washer, and securing split pin were still in position, but the brake cross stay was bent so that the left-hand end was some $3\frac{1}{2}$ in. in rear of the correct alignment of the right-hand end. There were marks of impact on the lower leading edge of this cross stay about 6 in. inside the left-hand brake hanger.

On the tender the upper side of the water scoop casting was broken. The lower portion of this scoop is made of thin sheet metal, and when in the up position it is closed by a baffle plate. Neither the baffle plate nor the sheet metal portion was damaged, and it appears reasonably certain that this damage was a result of the derailment.

Description of Permanent Way.

The curvature of the up branch line through the junction had a minimum radius of 16 chains. The common crossing adjacent to which the first marks of derailment were observed was 1 in 12, and the diamond crossing of the up branch line over the down main line was 1 in 8.

The track approaching and through the junction was 95 lbs G.N. Standard material laid in 1914, with the exception of the switches and the 1 in 12 crossing, which were laid in 1928 and 1935 respectively, with 95 lbs. British Standard material. Fastenings generally were two coach-screws and two spikes, and the ballast was slag.

The track through the junction and the diamond crossing was not seriously damaged and had not to be renewed. At the time of my inspection this portion was generally in good condition, fastenings being secure, with no signs of side-cutting by chairs into sleepers.

Measurements of gauge taken after the accident, on the portions of the track which were not seriously damaged, indicated an average of $\frac{1}{4}$ in. slack from the toe of the points to beyond the nose of the crossing (100 ft. from the toe), the extreme variation being $\frac{1}{8}$ in. tight at one point; beyond the crossing and through the throat of the diamond (160 ft. from the toe), gauge varied from $\frac{1}{8}$ in. slack to $\frac{1}{4}$ in. tight.

On the same length superelevation commencing with $1\frac{1}{8}$ ins. rose to $1\frac{5}{16}$ ins. and then fell to $\frac{1}{2}$ in. at the nose of the crossing, rising thereafter to $1\frac{1}{2}$ ins. and $1\frac{3}{16}$ ins. through the diamond.

In the circumstances, however, too much weight should not be given to these measurements taken subsequent to re-railing of several vehicles and renewal of the adjacent portion of the track.

The nose of the crossing was broken, particulars below; the gap at the throat was $2\frac{1}{4}$ ins. and the clearance of the check rail of the crossing was $1\frac{3}{4}$ ins. There were no serious signs of wear at the throat or on the check rail.

The first mark on the permanent way was on the check rail of the crossing, which had two flange marks, the first of which commenced 3 ft. 4 ins. before the nose of the crossing and traversed the head of the check rail at an acute angle, coming down into the four-foot about 5 ft. further on; the second flange mark was approximately parallel about 2 ins. away.

Portions of metal were broken away from the nose of the crossing to a depth of $\frac{1}{4}$ to $\frac{1}{2}$ in. on both sides, on the turn-out side for a length of $3\frac{1}{2}$ ins. and on the straight line side for about 1 in. From the evidence it seems doubtful whether either of these breakages was new.

There was a mark crossing the point rail (main line) beyond the nose, on the alignment which would be followed by a left-hand wheel if its right-hand wheel had climbed and traversed the check rail, but it could not be determined with certainty whether this was a new flange mark or the edge of the normal worn area.

On the fourth sleeper beyond the nose of the crossing there were marks on chairs and keys outside the left-hand rail and inside the right-hand rail; on the fifth sleeper the left-hand key was marked and on the right-hand side the end of the wing rail of the diamond was bent down, with a flange mark traversing this from the end for about 18 ins., going off again into the four-foot, and a chair jaw was broken.

Beyond this up to the centre of the diamond there were various marks and damage to chairs on the outside of the left-hand and inside of the right-hand rail, with fish-bolts sheared on the outside of the left-hand rail at the next joint, and a mark on the rail top of the left-hand rail of the main line where a wheel had apparently been dragged across.

Approaching the centre of the diamond another fishplate was marked and bolts sheared outside the left-hand rail, while immediately opposite the end of the check rail was bent down with a long flange mark over the top of the check, falling again into the four-foot.

Immediately beyond the throat of the diamond there were two marks where wheels had apparently been forced sideways across the top of the right-hand check rail, and, almost opposite, a flange mark on the top of the left-hand rail from the six-foot side, falling back on to the six-foot side.

Thereafter chairs were marked or broken on the left-hand side of both rails until a short distance beyond the diamond, and subsequently flange marks on sleepers, chairs broken or marked, and fishbolts sheared; this continued up to the point where the engine came to a stand, but the rails were standing up in the chair jaws and the right-hand rail remained comparatively rigidly supported.

Conclusion.

All the evidence, except the general impression of the engine crew, appears to point to some of the coupled wheels of the engine as having been the first wheels derailed. Apart from the absence of marks on the flanges or treads of the tender wheels, the distortion of the engine-tender safety links can only have been caused by lateral and vertical displacement, such as would arise when the engine coupled wheels were off while the tender wheels were on the rail.

The possibility of derailment originating with the wheels of one of the coach bogies may, I think, be dismissed, as not only is it most unlikely that such derailment would pull the engine off, but also any such result would mean that the tender was off before the engine.

Assuming, therefore, that two of the engine coupled wheels were responsible for the two closely adjacent lines over the check rail opposite the first crossing, the possible causes of such derailment appear to be:—

(*a*) Obstruction, probably in the flange way of the check rail.
(*b*) Defective track.
(*c*) Defective locomotive.
(*d*) Excessive speed.

or a combination of any or all of the latter three.

Considering (*a*) *Obstruction*; in the flange way of the check rail, there were no signs of an obstruction, and it seems unlikely that if an obstruction had been present it would have failed to derail the bogie wheels first. The permanent way gang were working in the immediate vicinity, but all their tools, etc., were subsequently checked and found correct, and apart from the engine bogie wheels mentioned above, another train had passed over the line only a few minutes earlier and after the gang had ceased work. As far as can be ascertained, nothing was missing from, or broken off, the engine or vehicles of this train.

The only portions of equipment missing or broken on the engine and tender of the derailed train were the brake block in rear of the left trailing coupled wheels, and the tender water scoop, neither of which could have caused derailment of wheels ahead of them.

I think, therefore, that the possibility of derailment being due to an obstruction must be dismissed.

(b) *Defective Track.*—The track, although not perfect, was on the whole in good condition, of adequate strength, and satisfactorily maintained, and I am satisfied that the work being executed by the gang that morning was not such as to affect it adversely. I do not think that there is any reason to consider that the derailment can be attributed in any appreciable degree to defective track.

(c) *Defective Locomotive.*—With the exception of one point, the examination of the locomotive after the accident indicated no signs of excessive wear or other defects which would have had any material bearing on the derailment. The one point referred to above is the weights on the various wheels, which were appreciably different from the designed weights, in particular on the wheels of the leading coupled axle.

It must be recognised that these differences may to some extent have been due to the derailment, and may not have been in existence previously, but I think it is reasonably probable that uneven distribution of weight may have had some bearing on the derailment, as explained in more detail below.

(d) *Excessive Speed.*—Considering the possibility of derailment being due mainly to excessive speed, I do not question the evidence of Driver Green, which is supported by a number of other witnesses, that he made a brake application about the distant signal and had effected a material reduction of speed by the time the engine passed the signal box. But I feel considerable doubt as to the accuracy of his estimate of a speed of 20 m.p.h., and I do not think that the evidence of most of the other witnesses is of much value on this point. It was not their business to assess the speed; no doubt they noticed the brake application and the speed reduction, and recollecting these afterwards they might well have thought that they remembered that speed was reduced to a normal figure.

It is a matter of common knowledge that after running at high speed there is tendency, in the absence of a speed indicator, to over-estimate the degree of reduction effected by a brake application.

The train in question is booked to cover the 21 miles from Lincoln to Sleaford in 27 minutes start to stop, and on this occasion apparently covered the the 18 miles to Sleaford North Junction distant signal in 21 minutes, and according to signal box timings had run 11·13 miles in 11 minutes approaching this signal. As noted above, it is common practice for speeds of 70 m.p.h. to be attained by express trains on this section, and I think it may be assumed that the maximum speed attained by this train was in excess of the 50 to 60 m.p.h. estimated by some witnesses travelling on it.

I think therefore that it must be recognised as a distinct possibility that Driver Green may have considerably under-estimated his speed through the junction.

He was of the opinion that he passed through the junction at about 20 m.p.h.; he stated that his regulator was then closed, that the brake handle was in the running position, and that he had not re-opened the regulator prior to becoming aware of the derailment. In view of the effect of the curvature on the train, it appeared probable that there was some inconsistency between these two statements, and I had the opportunity of making a trial with the same engine, after overhaul, fitted with a speed recorder and a train of identical composition.

Unfortunately, the driver slowed down rather below 20 m.p.h. through the junction, and it was not possible to obtain exactly the conditions desired, but it was clear that, even if the train was capable of coasting round the curve, as the driver assured me was the case, the speed would become abnormally low, and I do not think that Driver Green, who had been running 8 minutes late, would have allowed it to slow down to such a degree. So for this reason also, I think it is probable that the speed through the junction was in excess of 20 m.p.h.

Turning now to more positive evidence, the effects of derailment and the damage caused to the leading coaches of the train are, in my opinion, altogether inconsistent with a speed of 20 m.p.h., and the general results appear to indicate a speed more in the neighbourhood of 40 m.p.h. or over.

A similar indication is afforded by the distance the engine travelled after the breakage of the vacuum pipe on the tender and with the regulator closed.

Although prior to the accident no complaints had been made by the Permanent Way Staff of speed in excess of the authorised restriction through this junction, I was informed that since the accident, and in spite of all the publicity of the case, trains have been timed through the junction at speeds of 37 and 40 m.p.h., and in the down direction, which is subject to the same limit, as high as 47 m.p.h. Such disregard of the 20 m.p.h. restriction is strongly to be deprecated, and I understand that suitable steps have been taken to deal with the matter.

The fact that the marks of right wheel flanges mounting and traversing the check rail are almost exactly opposite the point at which the left wheel flanges begin to lose the lateral support of the rail approaching the crossing can hardly fail to be significant. Actually the gauge line of the left rail prolonged backwards from the nose of the crossing touches the wing rail 4 ft. 0½ in. before the nose, while the flange marks across the check of the right rail commence at 3 ft. 4 ins. before the nose.

Calculations have been made to determine the theoretical lateral and vertical forces acting on the outer leading coupled wheel, and at a speed of 40 m.p.h. with superelevation of ¾ in. the load on the outer leading coupled wheel works out at 10·8 tons, the lateral flange pressure being 7·5 tons. Thus assuming that the normal loading on each of the leading coupled wheels was correct, i.e. 9 tons on each, it would result that, owing to inadequacy of superelevation due to the junction and diamond, the inner leading coupled wheel would have been carrying a reduced load of 18—10·8 tons = 7·2 tons only.

But it may well have been the case that some or all of the discrepancy in weights as measured after the derailment was in existence prior to derailment, in which case calculations show that the inner leading coupled wheel might have been carrying 6·2 tons only at 40 m.p.h., while the lateral flange pressure was 7 tons, the corresponding figures at 50 m.p.h. being 5·2 tons and 10·2 tons respectively.

Beyond this the weight on the inner wheel may have been further reduced by the whole or any portion of the hammer blow, which at 40 m.p.h. is ·64 ton, and by any momentary transference of weight caused by a lurch outwards round the curve.

Thus it is quite possible that as soon as the left-hand rail began to fall away from the flange of the outer leading coupled wheel, the whole or most of the lateral stress of 7 tons was taken between the check rail and the back of the flange of the inner leading coupled wheel, the vertical load on which may have been appreciably less than 6·2 tons, while if a speed higher than 40 m.p.h. were assumed the discrepancy between lateral and vertical pressures would increase rapidly.

At the same time, due to the curvature, the leading edge of the flange of the inner wheel would be meeting the check rail at an angle, resulting in a biting action and a natural tendency to climb.

Having regard to the foregoing considerations, I think that there can be little doubt that the derailment was mainly due to the speed through the junction being considerably in excess of the 20 m.p.h. authorised limit, probably owing to Driver Green having over-estimated the degree of reduction of speed effected by his brake application at the distant signals. The risk of derailment would have been somewhat enhanced if the incorrect wheel and axle weights measured after derailment were in existence, or partially in existence, before the accident, but on this point it is impossible to express a definite opinion.

I therefore hold Driver Green mainly responsible for the derailment; he is 59 years of age and has 40 years' service with the Company, having been a driver for 20 years. He has a very good record.

The exact sequence of events after derailment of two pairs of coupled wheels is necessarily speculative, but it is easy to imagine that the blows given to the derailed wheels at the diamond might be sufficient to derail the trailing coupled wheels and thereafter, the outer jaws of the chairs of the left-hand rail being broken by the flanges of the derailed wheels, some lengths of the rail would be left with little or no lateral support.

One of the coach bogies, possibly of the second coach, might thus become partially derailed, strike some obstacle such as a chair and take a sheer to the left, ultimately twisting the leading coach over sideways into a position which would account for the peculiar manner in which the tender coupling was detached; the momentum of the following coaches, six of which were still on the rails, acting against the resistance of the overturned first coach, would force the second and third coaches out to the left into their final position.

The fact that the left-hand engine coupled wheels were only just outside the rail might hold this in position enough to prevent the tender being derailed until the last moment, possibly the moment of the lateral jerk from the overturning of the leading coach, and this theory is supported by the absence of marks on the flanges or tyres of the tender wheels.

Recommendations and Remarks.

It is inevitable that there should be a number of places on any railway line where there are very definite limits of safe speed, and for such places suitable speed limits are prescribed after consideration by the Engineer of all relevant conditions, mainly of track and curvature. It is necessary for drivers to acquaint themselves with these restrictions when learning the road and to obey them when driving, and in many cases it would not be fair or reasonable to leave it to the discretion of a driver to determine at what speed he may safely run. But, the safe speed having been specified by the Engineer, it has been held for many years past that reliance should be placed on the engine driver to judge his speed with sufficient accuracy in the observance of the specified restrictions, and, broadly speaking, this policy has been justified by results.

But "speeding up", which has had to be adopted in recent years and is likely to continue, has modified the situation owing to the feature, mentioned above, of the increasing difficulty in judging correctly a moderate or low speed after an abrupt reduction from a much higher speed, while at the same time, if the normal running speeds on straight and open line are increased, it is the more important to observe and obey the restrictions imposed for safety reasons at special places.

The provision of speed indicators, with or without recorders, is common practice on fast locomotives throughout the world, and they are being fitted to some of the most recent express locomotives on this and other Companies' lines in Britain. I would draw attention to Colonel Mount's remarks on the same subject in his Report on the accident which occurred at Carlisle in 1931 and endorse his recommendation that the provision of speed indicators on locomotives which have to operate high speed trains is a matter which merits the serious consideration of the Companies and one likely to afford material assistance to drivers.

In the same Report reference is made to the advantages of providing local indications of permanent speed restrictions as a further measure of assistance to drivers.

A further point in the same connection is the desirability of the Permanent Way Staff being impressed with the importance of reporting cases in which a local speed restriction is seriously or frequently infringed. The responsibility for determining a safe speed must lie primarily with the Engineer, whereas the responsibility for observing this speed lies with the driver.

I think it is probable that if the tender coupling had been of the Buckeye type the results of initial derailment would have been much more limited; this type of coupling is fitted to the tenders which have a Pullman Vestibule corridor connection, but I understand that there are practical objections to fitting it unless accompanied by the Pullman Vestibule.

I have the honour to be,

Sir,

Your obedient Servant,

A. C. TRENCH,

Colonel.

The Secretary,

Ministry of Transport.

APPENDIX.

Summary of damage to Rolling Stock.

Vehicle.	*Particulars of Damage.*
Engine and Tender.	Driving wheels abraded. Tender lifeguards bent, water pick-up scroop broken, tender screw coupling displaced.
Corridor Locker Third No. 61798.	Trailing bogie displaced, one cellbox broken, brakeshaft displaced. Trailing end stove in, faceplate bent, one corridor light broken.
Corridor Third No. 61736.	Practically wrecked, both bogies displaced, body considerably damaged.
Corridor Composite No. 63798.	Leading end bogie displaced, trailing bogie buried to solebars, cellboxes damaged. Seven corridor lights broken. Buckeye coupler broken at leading end.
Corridor Van No. 6752.	Decolite floor damaged. Roof millboard displaced.
Corridor Third Brake No. 62763.	Undergear damaged.
Corridor Composite No. 63825.	Undamaged.
1st Restaurant Car No. 661. Open Third No. 6103. Corridor Composite No. 63861. Corridor Brake Third No. 62539.	Undamaged and proceeded on journey.

Summary of damage to Permanent Way.

Seven 45 ft. rails, 480 chairs, 222 sleepers, together with a number of fishplates and bolts, screws, spikes, etc.

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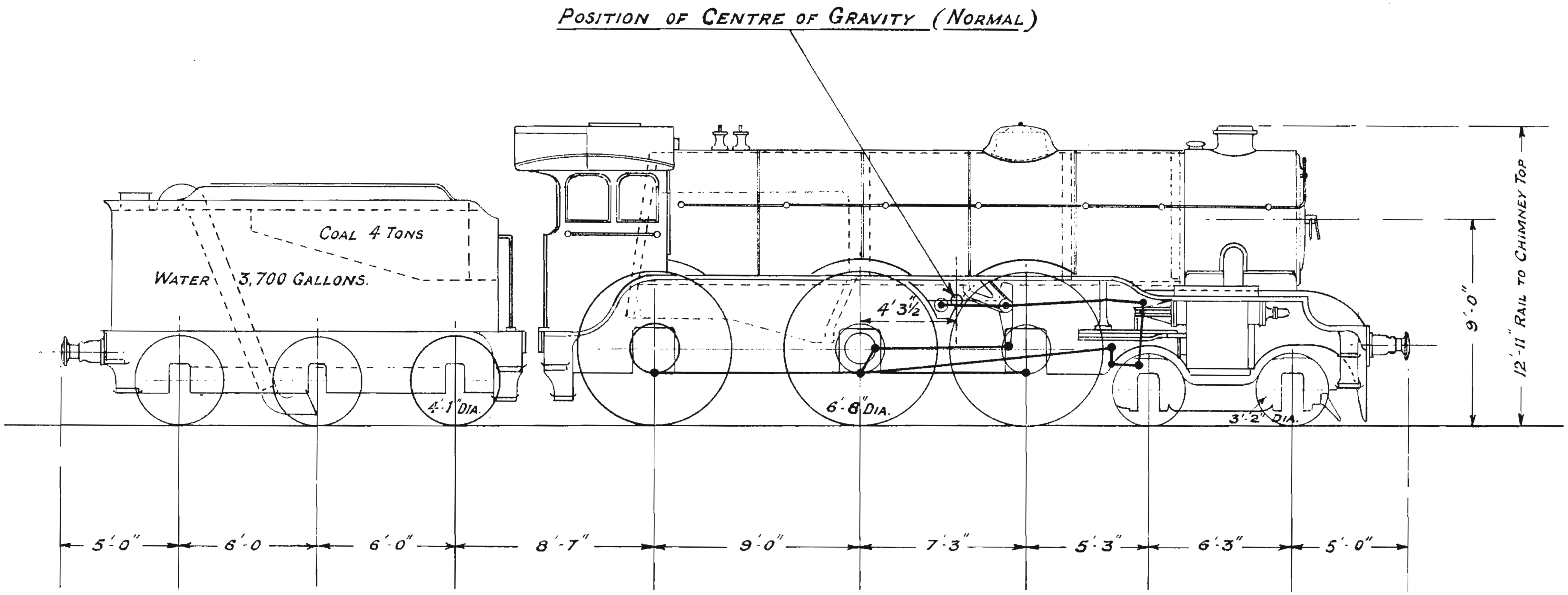
L.N.E.R. Engine Nº 2829 "Naworth Castle"



T. C. Q	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.	T. C. Q.		
14-8-0	13-9-2	11-10-2	17-15-0	18-0-0	18-0-0	22-18-0		Designed Axle Weights
11-13-0	10-15-0	11-11-0	18-19-1	16-2-0	15-11-0	25-5-3		Axle Weights after Derailment
						T. C. Q.	T. C. Q.	
5-18-0	5-3-0	5-17-0	9-9-2	8-1-0	8-4-0	6-8-3	6-4-2	L.H. Wheel Weights after Derailment
5-15-0	5-12-0	5-14-0	9-9-3	8-1-0	7-7-0	5-19-2	6-13-0	R.H. " " " "

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