GREAT WESTERN RAILWAY.

MINISTRY OF TRANSPORT,
4, Whitehall Gardens,
London, S.W.1.
25th February, 1936.

SIR,

I have the honour to report for the information of the Minister of Transport, in accordance with the Order of the 15th January, the result of my Inquiry into the circumstances of the accident which occurred on that date, at about 5.24 a.m., near Shrivenham Station on the main line of the Great Western Railway.

The 9.0 p.m. up express passenger train (including sleeping cars), Penzance to Paddington, travelling at 50 to 60 m.p.h. under clear signals, came into violent collision with a stationary brake van and 5 wagons, the rear portion of the 10.30 a.m. up special mineral train, Aberdare to Old Oak Common, which had become divided as the result of the breakage of a drawhook.

It is estimated that there were about 100 passengers in the train, and I regret to report that one lady (who was probably travelling in the leading coach) and Driver E. A. Starr were fatally injured. In addition, 10 passengers were seriously injured, most of them also having travelled in the first coach, while 17 others and Fireman J. H. Cozens of the express suffered from minor injuries and shock.

It was a dark, cold night; the Meteorological Office, Air Ministry, reported that at Marlborough, some 12 miles distant, for the 24 hours ending at 9.0 a.m. on the 15th January, minimum temperature and grass minimum were 24° F. and 17° F. respectively. The temperature at 9.0. a.m. was 27.9° F., weather conditions being reported as " Overcast, mist, hoar frost, overhead fog ". With regard to visibility in the neighbourhood of Shrivenham, the evidence of the men concerned varied considerably, owing to low-lying patchy mist, steam, and smoke.

Effects of the Collision, Damage, etc.

The mineral train was hauled by engine No. 2802, type 2-8-0, with a 6-wheeled tender, weighing in working order 108 tons 6 cwts., and fitted with the vacuum brake working blocks on all the coupled and tender wheels. The train comprised 53 loaded wagons, with a 24-ton 6-wheeled brake van, No. 56923, in rear; the tare weight of the train was 374 tons 19 cwts. and the load (coal) about 625 tons. The total weight of the train was roughly 1108 tons, and its overall length 1109 feet.

The division occurred between the 48th (12-ton) and 49th wagons, the rear drawhook on the former having broken; the marshalling of the remaining wagons was 49th, 20-ton; 50th, 10-ton; 51st, 10-ton; 52nd, 10-ton; 53rd, 12-ton. The total weight of the 5 wagons and brake van was approximately 121 tons 15 cwts. Only the 20-ton wagon and the brake van had oil axleboxes.

The van was 24 ft. long overall, and had a wood and steel body, on a heavy steel frame. The rear portion, consisting of a verandah 6 ft. 6 ins. wide, with the brake handle in the centre of it, was destroyed, but the body withstood the shock well. The 3 wagons in rear were wrecked, while the 2 leading wagons became detached when the collision occurred, and were propelled for no less than 1½ miles up the line.

The express was hauled by engine No. 6007, King William III, 4-6-0 type, with a 6-wheeled tender. It weighed in working order 135 tons 14 cwts., and was fitted with the vacuum brake operating blocks on the coupled and tender wheels, and on all wheels of the train, which comprised 9 bogie coaches, weighing 328 tons 6 cwts., screw coupled and electrically lighted. The marshalling of the train, and particulars of construction and damage are given in Appendix I; the total weight, including load, was approximately 474 tons, and the overall length was 688 ft. 6 in.

Much of the force of the collision was taken by the frame of the goods brake van; but its wheels and those of the 3 wagons in rear (which collapsed with their coal) were piled into a heap, into which the engine ploughed its way, and unfortunately turned over on to its right side, with the boiler along the centre of the down line. This caused violent stoppage of the express, the shock of which was taken chiefly by the first 2 vehicles.

The couplings at each end of the leading coach, a corridor third, became unhooked; the buffers were of the oval pattern. The coach was built in 1921 and had a heavy steel underframe with a body constructed of wood, steel-panelled,

and a roof of wood; the frame was thrown out sideways, clear of the train, across the down line. The body was projected beyond its frame and rolled over down the bank, coming to rest almost upside down, with the remarkable result that the first 5 doors on one side, and 4 on the other, were still capable of being opened; but the 5 rear compartments were destroyed.

The second coach, an ordinary brake van, was also destroyed. Built in 1910, it had a wood body on a steel underframe. The leading coupliug also became unhooked; the buffers were of large diameter round type. The frame forced the tender out of alignment, and the leading end came to rest adjacent to, and overhanging, the engine cab. Fortunately there was no one in this vehicle, aud it had been converted from gas to electric lighting in 1931. The rear coupling remained coupled.

The third vehicle was a first-class sleeper, built in 1929, having a massive steel underframe, the body and roof being entirely encased in $\frac{1}{16}$ in. steel plating. It withstood the shock very well, and, although derailed, it kept its alignment, and damage was not serious. No telescoping occurred, and the large diameter buffers appear to have contributed to this. The fourth vehicle, a third-class sleeper, was also derailed, but kept its alignment and was comparatively little damaged; it was of the same construction, built in 1929. The couplings of these two coaches remained coupled and suffered little damage. The other coaches remained on the road, but each was slightly affected as shown in Appendix I.

Some 220 yards of permanent way in the up and down lines had to be relaid. Both were blocked for about 20 hours, viz., until 1.35 a.m. next morning.

Description.

The Company's main (double) line here lies in an east (Didcot and London) and west (Swindon) direction; the site of the collision was in bank, some 13 feet high, about 72¼ miles from London. The gradient in the up direction falls at 1 in 834 the whole way from Highworth Junction, through Marston Crossiug and Shrivenham, for a distance of about 5 miles.

The mineral train became divided on this falling gradient at 73m. 51ch., at which point, in the 4-foot of the up main line, a piece of drawhook (broken through the Gedge slot) of a Private Owner's wagon was found; the brake van and five wagons thereafter travelled by their own momentum, first, over about six furlongs of right-handed curve of 350ch. radius, and thence for five furlongs on tangent, until they came to rest at the site of the collision, 444 yards in advance of Shrivenham Station up distant signal.

The station has recently been reconstructed with four tracks, the signal box being located at the west end; the up platform line joins the up goods line at Ashbury Crossing box, at which point (beyond the east end of the station) the mineral train was diverted from the up main, to allow the express to pass.

The approximate distances from Shrivenham box to the other boxes, signals, &c., relevant to this case are as follows :—

Swindon	5 miles,	1056 yards,	West.
Highworth Junction Box	4 ,,	1144 ,,	,,
Marston Crossing Box	2 ,,	836 ,,	,,
Portion of drawhook found on up line	1 ,,	1650 ,,	,,
A.T.C. ramp	1 ,,	204 ,,	,,
Up Distant signal for Shrivenham		1508 ,,	,,
Site of collision and rear end of standing wagons		1064 ,,	,,
Leading end of standing wagons ...		1022 ,,	,,
Engine (front) came to rest on its side		977 ,,	,,
Commencement of track circuit in rear of Shrivenham home signal		846 ,,	,,
Up main home signal, with up distant for Ashbury Crossing under it		345 ,,	,,
Facing connection in up main serving up platform line ...		140 ,,	,,
East End of goods shed		120 ,,	East.
Centre of Shrivenham Station platforms		300 ,,	,,

Ashbury Crossing Box		1122 yards, East.	
Facing connection in up main serving up goods line		1192 ,,	,,
Knighton Crossing Box	2 miles	1232 ,,	,,

Shrivenham and Ashbury Crossing boxes are of the Company's latest type, with mechanical frames. Each commands an excellent view from the south side of the line. Shrivenham has 36 working levers and 4 detonator placers; occupation of the track circuit in rear of the up home signal prevents *Line-clear* being pegged to Marston Crossing. Ashbury Crossing has 23 working levers, 2 detonator placers, a gate wheel and 2 wicket levers.

Report and Evidence.

1. The coal wagon concerned, G.L.M., No. 53107, was of 4-wheeled type, 12-ton capacity, with a timber frame and body, and tare weight of 6 tons 17 cwt. It was built in 1921 by Nixons Navigation Colliery Co., Ltd., Cardiff, and is now owned by Messrs. Stephenson Clarke and Associated Companies, Ltd. It had grease boxes, self-contained buffers, and two independent single brakes.

The wagon was plated on the 24th September, 1932, as having been Generally Repaired at the Cambriau Wagon Co.'s Works, Cardiff, the work having consisted mainly of repairs and replacements to body timbers. It had not been stopped for repairs since that date.

The drawhook which failed was the original one fitted when the wagon was built, and was manufactured by Head Wrightson Co., Ltd., Thornaby-on-Tees; it had failed through the Gedge slot of the hook, the fracture being of coarse crystalline appearance, with a slight, though not growing, flaw at the top or tension side. The cross-sectional area at the point of fracture was 5.9 sq. ins.

The material was wrought iron, and the dimensions of the hook conformed with the applicable R.C.H. Regulations. The report upon the results of the chemical analysis and physical tests, which were carried out by the Railway Company, is attached as Appendix II. The conclusions are noteworthy.

2. The mineral train left Highworth Junction at 5.0 a.m., after having beeu delayed at Swindon for three hours. According to Driver D. G. Davis—a reliable witness, who had regularly operated goods trains over this road, which he knew well—the train passed Marston Crossing at about 20 m.p.h.; he had not checked the time there, but had looked back and observed the right-hand side light. When approaching Shrivenham, Davis observed the up distant at clear, and midway between it and Ashbury Crossing distant, which was at warning, he closed the regulator, and, by application of the hand brake, reduced speed to 10 m.p.h. through the station, according to his estimate. He looked at his watch (which had been checked at 10.0 p.m.) when passing the station, and noted the time as 5.14 a.m. He said that the train entered the loop at Ashbury Crossing at 5.15 a.m., travelling at 4 m.p.h. Thereafter he accelerated to 8 to 10 m.p.h., and came to a stand (5.25 a.m.) at the home signal at Knighton Crossing; it was not until 5.29 a.m., when he heard from the signalman there, that he realised that a breakaway had occurred.

The train entered the section at Marston Crossing at 5.8 a.m., and the above-mentioned times correspond with the corrected records of Shrivenham, Ashbury Crossing, and Knighton Crossing boxes. The accuracy of these clocks is referred to later.

Davis felt no snatch of any kind and had not the slightest suspicion that a division had occurred. After leaving Swindon, he did not touch the regulator until he closed it, as described above. He had not looked back when entering the loop at Ashbury Crossing, as that was not customary. He said that visibility had been good up to Shrivenham, but intermittent mist appears to have prevailed thence to Knighton Crossing, and "*visibility was perhaps restricted to* 60 *yards.*"

Fireman P. T. G. Jenkins confirmed his driver's evidence; he had also looked back at Marston Crossing and observed the left-hand side light, but he did not do so when entering the loop at Ashbury Crossing. He described visibility as patchy, but had had no difficulty in observing signals; nor had difficulty been experienced with the engine, which had worked through from Aberdare. He also was a good witness, but was unable to give any estimate with regard to the speed of the train.

Guard H. E. Chandler, of Severn Tunnel Junction, was in charge of the mineral train; he had booked on duty there at 8.20 p.m. the previous evening. He was in the spare link, and the last time he had worked over the road was some

four months previously, but he said he knew it " *well enough to work a train over it.*" He had checked his watch by wireless at 6.0 p.m. and had found that it was losing perhaps two minutes per day in the cold weather.

According to his statement, the train left Highworth Junction at 4.59 a.m. His account was as follows :—

> " *I did not notice Marston Crossing box. I was sitting in my van engaged on other duties. I was preparing the London Division journal, and I did booking on Mr. Pole's journal. I was also consulting my service book to see the train service back from Didcot in the event of my being relieved there . . . .*
>
> *I cannot therefore say the time we passed Marston Crossing, but I should say we were travelling at 18 to 20 miles an hour, which is the normal speed. . . .*
>
> *I cannot remember what I was actually doing when I began to realise we were slowing up, but a couple of minutes afterwards I looked at my watch and saw it was 5.15 a.m., and after a further period of five minutes I realised we had come to a stand. I looked at my watch again and it was 5.20 a.m. After coming to a stand I applied my brake very slightly.*
>
> *I personally was of the definite opinion that the whole of the train was intact, and that we had come to a stand at Shrivenham home signal.*
>
> *After coming to a stand, I looked through the end window of my van and sighted the Shrivenham signal box. I went through my van on to the verandah which was at the trailing end, and looked along the train with a view to seeing whether my train was intact and whether we were in fact at the home signal. It was then that I realised that my train had parted and that I only had the brake van and five wagons . . . .*
>
> *A glance to the rear a fraction later showed to my horror an express approaching on me. I gathered my flags and detonators, and, waving a red hand lamp violently, I raced to the rear, but I had not time to place down detonators . . . .*
>
> *I should say the express was about a mile or a mile and a half away when I first saw it. It is a perfectly straight road and I could see the head lights of the engine. I immediately raced back on the 6 foot side of the down main line and should say I ran back about 75 yards, but I am not quite sure of the distance. My tail lamp and side lamps were burning correctly, showing three reds to the rear. The weather was fairly good. There was a little mist in places, but nothing to speak of. I did not know the express was following me. I did not look at my watch at the time the collision took place.*"

Questioned with regard to this evidence, Chandler said that the door of his van was shut; his fire was alight, but it was not exceptionally warm. He was neither drowsy nor tired. He felt no jerk hard enough to break a drawhook; in fact, the train ran from Swindon " *perfectly smoothly*". He was not expected to book the time of passing Marston Crossing, but he anticipated reaching Shrivenham at about 5.15 a.m. He did not, however, look out at this time, or subsequently, when, according to his account, he looked at his watch, because he " *assumed the driver had sighted the distant signal at Caution, and I thought the driver was pulling up at the home signal* "; on the other hand, he could not recall that, in doing so, the buffers made any noise.

Chandler asserted positively that he looked at his watch at the times stated, and he suggested that the collision occurred at about 5.23 a.m. He agreed that his van must have been gradually coming to a stand for about 7 minutes; but he was indefinite as to the period which subsequently elapsed before he acted. As to what he was doing at the time, he said " *I was actually looking at my Service Book to ascertain the time of trains home from Didcot if I was relieved there, when I realised that we had come to a stand.*" He had never experienced a breakaway, and had not previously had to protect a goods train in rear.

3. Fireman J. H. Cozens, of the express, an excellent witness, aged 37, with 17 years' firing experience, stated that the run from Newton Abbot, where he and Driver Starr took over, had been quite satisfactory, and that the train left Swindon on time at 5.15 a.m. He said that " *visibility was not too clear, but not sufficient to have fogmen out* "; maximum speed had not been attained when the collision occurred, but he estimated that it was 50 m.p.h. when he heard the clear signal bell on passing the Automatic Train Control ramp (455 yards in rear

of Shrivenham distant signal). In accordance with his custom he looked up, observed the signal showing the clear indication, and carried on with his firing duties. Having put on two or three shovels of coal, he looked up again, observed the three red lights (one tail and two side) on the brake van ahead, and shouted to his mate. Starr apparently saw them at the same moment, and "*he immediately shut off and applied the brake; he lost no nerve, and acted as though it were an ordinary signal.*" Cozens said that the lights appeared to be rushing towards them; "*it seemed as though we were on them as soon as they were seen.*" He felt the retardation of the brake, and speed was "*somewhat reduced*" before the collision occurred. But for the obstruction, he thought that the train might have been brought to a stand in a "*few hundred yards*". He had worked with Starr for about two years, and said he was an exceptionally careful man.

There was evidence to the effect that immediately after the accident the reversing lever was found in fore gear and in 15 per cent. cut off. Two hours later the regulator was noted as being closed, but its position and that of the ejector handle might have been affected by the turning over of the engine; they might also have been moved when Starr and Cozens were extricated, but the condition of the tyres and brake blocks showed that a severe application of the brake had been made just previous to the engine coming to rest.

Guard J. W. Rapson, who had taken over the train at Plymouth North Road, confirmed that it left Swindon on time at 5.15 a.m., by the station clock and by his watch which he had checked at 12.5 a.m.; the latter did not lose more than half-a-minute in 24 hours. There were some 28 passengers in the front coach on leaving Newton Abbot, and six joined later. He had worked on the train for six months, two weeks out of three. The time allowed for the run from Swindon to Didcot, 24¼ miles, was 27 minutes, and he thought that maximum speed of just over 60 m.p.h. was usually attained between Shrivenham and Challow.

Rapson was travelling in the rear coach (ninth), getting letters ready to put out at Didcot; he considered that speed was normal at the time of the accident, about 50 m.p.h. His account was that the train began rattling and shaking very badly, when a moment later the shock of the collision was felt, the lights went out, and the train came to a stand. He had no doubt that an emergency brake application had been made. His lamp fell over and went out; he immediately re-lighted it, picked up his detonators, lowered the window, opened the door, jumped on to the line, proceeded a few yards, looked at his watch, and noted the time as 5.25 a.m. Checked by watch, Rapson estimated that from the time of the collision to the time of looking at his watch was about one minute, and there was evidence that he was a quick-moving man. He took efficient and prompt protective measures.

Ticket Collector W. L. Ross was in the trailing sleeper (eighth) at the time and gave a corresponding account. His first sensation was a sudden jerk which threw him forward; he did not look at his watch. District Inspector T. Willmott, with two other employees, was travelling in the sixth coach, and gave confirmatory evidence; he also described the efficient way in which the staff generally acted in this emergency. Six doctors and six nurses rendered assistance; the relief train from Swindon arrived at 6.45 a.m. and left again at 7.40 a.m., removing all the injured and uninjured passengers, except three and Driver Starr, who had previously been sent to hospital by road ambulance.

4. The times which have already been quoted appear to be approximately correct. In the following evidence of the signalmen and throughout the rest of the Report, the recorded times at Shrivenham and Ashbury Crossing boxes have been synchronised. This point has been carefully considered in conjunction with the Company's officers, who, having regard to the fact that the express was running to time, were at first inclined to the opinion that the only clock which was correct was that at Swindon Goods Yard box, and that Swindon East was two minutes fast, Highworth Junction one minute fast, Marston Crossing one minute fast, Shrivenham one minute slow, and Ashbury Crossing three minutes fast. It is quite clear that the difference between the last-named clocks was four to five minutes; there is some ground for thinking it was nearer the latter, though the bookings indicated the former.

Having regard, however, to the evidence of the signalmen concerned (to be referred to later), to the foregoing statements of Driver Davis and Guard Rapson, and to the daily running time of the express, it is considered that the

assumption which is likely to be nearer the truth is that the clocks at Highworth Junction, Marston Crossing, and Knighton Crossing were correct, while Shrivenham was two minutes slow and Ashbury Crossing at least two minutes fast.

5. Signalman A. C. Bartlett, of Marston Crossing, referred to the mineral train having passed his box complete, with tail and side lights burning, at 5.8 a.m. according to his register (5.6 a.m. Shrivenham register), travelling at "*normal*" speed, for which, however, he hesitated to suggest a figure. He received the *Out-of-Section* signal for the train from Shrivenham at 5.15 a.m. He accepted the express at 5.16 a.m., and it entered the section at Highworth Junction at 5.18 a.m., at which time he received acceptance for it from Shrivenham (5.16 a.m. Shrivenham register). It passed the box at 5.22 a.m. (5.20 a.m. Shrivenham register) travelling at normal speed, 50 m.p.h., according to his estimate.

Bartlett said that when he received the *Out-of-Section* signal for the mineral train at 5.15 a.m., he received at the same time the *Entering-Section* signal for a down milk empties train, which passed Marston Crossing at 5.18 a.m.; he accepted the following down empty stock train at 5.21 a.m., but it did not arrive and he did not receive the *Entering-Section* signal for it. He received the *Obstruction-Danger* signal from Shrivenham at 5.37 a.m. (5.35 a.m. Shrivenham register).

Bartlett is 35 years of age and had been a signalman for 15 years, during the whole of which time he had worked "*entirely satisfactorily*" with Signalman W. Head of Shrivenham, who he considered was "*a very good and reliable*" man.

6. Signalman W. Head, of Shrivenham, had booked on duty at 10.0 p.m. the previons evening; he had slept well, he was not worried, and was enjoying good health. His account is as follows:—

> "*I was at the Swindon end of the signal box, looking out at the up goods approaching the signal box. I placed the up distant signal to Caution and remained there for the down milk empties were passing at the same time. I stayed that end to catch the tail lamp on the down milk train first, then turned to catch the tail lamp of the up goods, walking to the other end of the signal box at the same time to put the down signals to danger . . . I could swear that I saw what I took to be a tail lamp on the up goods when it was passing the goods shed. This was as I was walking up the frame in my box. There was just a very slight mist and a little steam from the down milk train, but not enough to make my view indistinct . . . . I then returned to give the "Out-of-Section" to Ashbury Crossing, also at the same time placing my up home and starting signals to danger. I then gave the "Out-of-Section" to Marston Crossing at 5.15 a.m. (5.13 a.m. in his register). The clearing point is ¼-mile from the up home signal.*
>
> *Probably when I gave "Out-of-Section" to Marston Crossing at 5.15 a.m., the train was passing through the station. I am quite certain the down milk empties and coal train were passing my box at the same time . . . .*"

Head demonstrated his actions in the box; he estimated that the mineral train passed at 10 to 15 m.p.h., and the milk empties train at 45 to 50 m.p.h. With regard to the express, he stated:—

> "*At 5.18 a.m. (5.16 a.m. in his register) I was asked "Line-Clear" from Marston Crossing for the 9.0 p.m. Penzance express, which I gave to him. At 5.22 a.m. (5.20 a.m. in his register) I accepted "Train-on-Line" from him. . . . About a minute afterwards I heard a bang and my up distant signal lever in the box shook very much. My first thoughts were that there were some cattle on the banks; I went immediately to the window to see if I could see or hear anything more. Not being satisfied, I rushed to the other end of the signal box and put my down signals to danger against the train of empty coaches that were signalled through to Marston Crossing. . . .*

With regard to the times when the guard arrived in my box at 5.58 *a.m., he showed me his watch and said that my clock was two minutes slow by his watch. I let it stay, as I knew my clock for some time had been losing anything up to* 2 *or* 2½ *minutes per day, as the booking shows. Here is the booking on Saturday, January* 11*th, to the effect that the clock was* 2½ *minutes slow at* 11.0 *a.m.*"

Head had accepted the down empty stock train at 5.21 a.m. (5.19 a.m. in his register), and it entered the section at Ashbury Crossing at 5.26 a.m. (5.24 a.m. in his register) under clear signals, at which time, or half a minute later according to Head, he threw up his signals against it; he thought "*it was possibly a minute or a minute and a half to two minutes before that, that I heard a bang.*"

It may be inferred from this estimate that the collision occurred between 5.24 a.m. and 5.25½ a.m.; on the other hand, there is Head's former statement that the bang was heard about a minute after he received, at about 5.22 a.m., the *Entering-Section* signal for the express. As, however, the express, travelling at 50 to 60 m.p.h., can hardly have taken less than two minutes to cover the distance from Marston Crossing to the point of collision, nearly two miles, there seems little doubt that the collision did not, in fact, take place much before 5.24 a.m., as is also apparent from Guard Rapson's evidence.

7. Driver F. Gould, of the down empty stock train, stated, and his fireman, H. J. Howard, confirmed, that they passed the Shrivenham down distant and home signals in the clear position; but they fortunately noticed that Head had reversed the starter, and the train was brought to a stand just beyond it and adjacent to the box. After ascertaining what had happened, they proceeded to the site of the accident, with one coach, under instructions from Inspector Willmott, and rendered valuable assistance to Cozens and others in releasing Driver Starr. Gould referred to changes in visibility as follows:—It was slightly misty on each side of Shrivenham, "*visibility looking through the eyeglass being between* 200 *and* 300 *yards,*" while it was "*practically clear*" when running through the station.

8. Signalman E. F. Jefferies, of Ashbury Crossing, had also booked on duty at 10.0 p.m. the previous evening. He diverted the mineral train on to the up goods loop, to allow the express to overtake it; such diversion was usually carried out at Ashbury Crossing and not at Shrivenham.

Jefferies received the *Entering-Section* signal for this train from Head at 5.14 a.m. (5.16 a.m. in his register), and he transmitted the same signal forward to Knighton Crossing at 5.15 a.m. (5.17 a.m. in his register). He stated, and it is confirmed by Driver Davis, that the train entered the loop at about 5 m.p.h., at this time, but it was not until 5.18 a.m. (5.20 a.m. in his register) that he transmitted the *Out-of-Section* signal for the train to Head (who recorded receipt at 5.17 a.m.).

The last-mentioned time is of importance with regard to Jefferies' responsibility, and to the running of the express, the corrected times of which are as follows:—Head's acceptance of the train is recorded at that time, 5.18 a.m., as already stated, and Jefferies accepted it a minute later, at 5.19 a.m. (5.21 a.m. in his register); but the train did not enter the section at Marston Crossing till 5.22 a.m., when Head transmitted the *Approach* signal to Jefferies (who recorded receipt at 5.25 a.m.). There was therefore an interval of as much as 4 minutes between the time Jefferies transmitted the *Out-of-Section* signal for the mineral train, and the entry of the express into the section at Marston Crossing.

Jefferies' account is as follows:—

"*At* 5.15 *a.m.* (5.17 *a.m. by his register*) *I put the* 10.30 *a.m. coal train Aberdare to Old Oak Common up the avoiding line to Knighton Crossing. . . . I watched part of the train by and was then called to the 'phone. On returning to the window the coal train had passed, and I thought I saw the tail lamp. I thought I saw a white light which the guard had changed. Before I gave 'Train-out-of-Section' for clearing the coal train, I followed the practice I had always done in this short section; I looked to satisfy myself that there was nothing between myself and Shrivenham. I do not do this as an alternative to my observing the tail lamp. I can see through the section.*

Later Signalman Head sent me the Emergency signal and informed me that wagons were passing him; I cannot say what time it was. I turned these up the avoiding line and turned back to main as soon as they cleared the points, thinking the express would be close. What I cannot remove from my mind is the fact that I feel positive.I saw a white light up the loop which I thought the guard had changed on entering. My reference to this means the white side light which would have been changed from red by the guard on entering the loop. . . .

With regard to my telephone conversation, Swindon West Box rang me up; the conversation started after I watched a part of the train go by. I could not say how long it lasted, nor could I say who the actual person was with whom I spoke. Usually the boy answers, but I do not know his name. He told me that the Gwinear was behind the Penzance. I said ' All right,' and that finished the conversation. I stood with my back to the line talking into the telephone, which is attached to the back wall of my box. After the conversation ceased I went to the open window at the London end of my box from which I had previously been observing the train."

By that time the train had passed, and Jefferies thought that the " *engine was perhaps near the starter*," 492 yards from the box. He was unable to say definitely whether he could have seen the tail light (had it existed) from where he was standing at the telephone, but inspection appeared to indicate that he might have been able to do so, though through closed windows.

Conclusion.

9. The division at the rear of this heavy mineral train was caused by the failure, through the Gedge slot, of the trailing drawhook on a 12-ton wagon, owned by Messrs. Stephenson Clarke and Associated Companies, Ltd. The hook was of standard construction, 15 years old, and the material, wrought iron, appears to have conformed with the specification in force at the time of manufacture; the wagon had been plated as recently as September, 1932, in accordance with the 7-yearly General Repair Programme.

No question arises with regard to the proper functioning of the drawgear; the failure was due to the poor shock-resisting property of the material, and, having regard to the existence of a small, but not growing, flaw, low temperature was probably a contributory cause. The flaw could not have been observed under any normal system of examination.

There seems to have been no feature with regard to the operation of the train which contributed to the fracture of this hook; speed at the time was at least 20 m.p.h., on a falling gradient of 1 in 834, and on an easy right-handed curve of 350 ch. radius. I conclude that the failure was the result of fatigue, and that no responsibility rests upon Driver D. G. Davis or Fireman P. T. G. Jenkins, who only became aware of the division when the train was stopped by signal at Knighton Crossing.

10. The express entered the section under clear signals at 5.22 a.m.; the wagons were standing nearly 2 miles away, and 444 yards ahead of the Shrivenham distant signal, which had also been cleared. Even if speed had then been as high as 60 m.p.h. (which is doubtful according to the evidence), the collision could not have taken place much before 5.24 a.m.

I have no reason to doubt that Driver E. A. Starr and Fireman J. H. Cozens were on the alert. Evidently they received the Automatic Train Control audible clear signal in their cab at a point 455 yards (little more than 15 seconds) before reaching the clear distant signal, and had no suspicion of impending disaster. According to the evidence, visibility through the eye-glass at the time may have been restricted to no more than 300 yards, and it was probably not till after passing the distant signal, in the intervening 444 yards, that Starr observed the red tail and side lights, and realised the danger.

The overturning of the engine caused the more violent stoppage of the train and the greater damage to the rolling stock. While Cozens was very fortunate to escape, Starr could not be released for two hours and evidently acted with great fortitude before succumbing to his injuries. He was 52 years of age, and had 38 years' service with an exceedingly good record as a main line driver.

11. After traversing the section from Marston to Shrivenham, 2 miles 836 yds., in six to seven minutes, viz., at an average speed of 21½ to 25 m.p.h., the leading part of the mineral train passed Shrivenham box between 5.14 a.m. and 5.15 a.m., travelling at 10 to 15 m.p.h. according to the evidence, Driver Davis having applied the brake before passing Ashbury Crossing distant signal at warning, in preparation for the diversion of the train into the goods loop. (The train was 370 yards long, and would have taken ½-minute to pass at 25 m.p.h.)

Assuming that speed was 25 m.p.h when the division took place, 1 mile, 1,650 yards before reaching Shrivenham box (where tbe broken piece of drawhook was picked up), it may be estimated that, at an average of 20 m.p.h (allowing for 15 m.p.h when passing through Shrivenham), the train covered this distance in about six minutes, and that the time at which the division occurred was 5.14 a.m. to 5.15 a.m. *minus* six minutes, viz. 5.8 a.m. to 5.9 a.m.

In decelerating from an initial speed of 25 m.p.h. to a state of rest, under their own momentum, on the falling gradient of 1 in 834, the brake van and five wagons traversed the distance of 1 mile 1,650 yards *minus* 1,064 yards (the distance of the point of collision from Shrivenham box) *plus* the length of six vehicles, 42 yards; viz. a net distance of 2,388 yards. Assuming constant deceleration, at an average speed of 12½ m.p.h., it may be estimated that this took 6½ minutes, and that the vehicles therefore came to rest at 5.8 a.m. to 5.9 a.m. *plus* 6½ minutes, viz. at 5.15 a.m., or nine minutes before the collision occurred.

It is clear that the assumed average speed of this train cannot be much reduced, as the period taken to cover the distance of 1 mile 1,650 yards (from the point of division to the box) could not have been much more than six minutes, because the train was recorded as having passed Marston Crossing complete at 5.8 a.m., and the failure took place 946 yards ahead of that box, to traverse which distance would have occupied about a minute.

If it be assumed, however, that the failure took place as late as 5.9 a.m., at a speed no higher than 18 m.p.h. (accepting the lowest estimate), the vehicles would have taken 9 minutes to come to rest at 5.18 a.m., again assuming constant deceleration at an average speed of 9 m.p.h.

On the other hand, calculation by a retardation formula, assuming resistance at 10 lbs. per ton, and making allowance for the falling gradient of 1 in 834, indicates that an initial speed at least as high as 25 m.p.h. was necessary for the vehicles to run as far as 2,130 yards. Indeed, the fact that they ran 2,388 yards suggests that the initial speed may have been a little higher, in which case, as in the first illustration, it would appear that the vehicles might have come to a stand rather earlier than 5.15 a.m.

These calculations do not confirm Guard H. E. Chandler's evidence; on the contrary, they indicate that he might have had as much as nine minutes for protective action. According to his own statement, he appreciated that deceleration lasted for about seven minutes, as compared with the above estimates of 6½ and 9 minutes. Taking account of his suggestion that his watch may have been a minute slow, he also estimated, and indeed affirmed, that this period commenced at 5.15 a.m. *minus* "*a couple of minutes*" *plus* one minute (for watch inaccuracy), viz., at 5.14 a.m.; he stated that the period persisted till the vehicles had come to rest, when, at 5.20 a.m., he looked at his watch again, which time, corrected in his favour and according to his evidence, should be 5.21 a.m. Thus, he suggested that there was an interval of no more than two or three minutes between the time of the vehicles coming to rest and the time of the collision.

It is quite clear that Chandler's account breaks down in respect of the important time, between 5.8 a.m. and 5.9 a.m., when deceleration commenced, viz., when the division occurred. Had this happened at 5.14 a.m., as he suggested, while the train was passing Shrivenham box (when Signalman Head transmitted the *Entering-Section* signal to Ashbury Crossing), the broken drawhook would not have been found two miles in rear of the box, but somewhere near it, and the detached vehicles would have come to a stand some distance ahead of the box instead of where they actually did. In fact, Chandler had failed to obey Rule 148 (*b*) and (*d*); he had neither kept a good look-out, nor had he applied his brake, although he thought that this heavy train was being stopped

at Shrivenham home signal, and this could hardly have been accomplished on the failing gradient without brake action on the part of the driver and some noise of the wagon buffers closing up.

Further, Chandler suggested that when he eventually came to a stand, 5.21 a.m., he immediately saw (a "*fraction later*") the headlights of the exp ss, one to 1½ miles away. The train, however, did not enter the section at Marston Crossing, which was two miles away, till 5.22 a.m., and his evidence of such extended visibility is not confirmed, though test showed that had the weather been clear he could have seen the headlights of the express at a range of a mile.

In all the circumstances, I regret that I am unable to accept Chandler's evidence, and I find that he was not really on the alert; while he realised that he was slowing down for so long a period as seven minutes, and may have thought that his train was drawing up to the home signal, it appears that he was preoccupied in consulting his Service Book with regard to his return journey after relief, and evidently he did not take the trouble even to try to observe this signal, or the distant signal, as was his duty. Indeed, it seems that the situation dawned on him only just in time to permit him to jump from his van and save his life.

If the most favourable assumptions be made in his interests as to the speed of the mineral train, and therefore of the initial velocity of the six vehicles, and if it be assumed that the time of the collision was as early as 5.23 a.m., my considered opinion is that Chandler had at least six minutes in which to take protective action. Had he acted promptly, as the result of having realised, during the long period of retardation, that his train had been drawing away from him, he could have brought the wagons to a stand much earlier by brake action; but even though he failed to do this, he should have been able, notwithstanding the slippery state of the ground, to place a detonator on the rail at least 300 to 400 yards in rear of his brake van, within the time at his disposal after it came to a stand. Although this might not have prevented actual collision, such warning would probably have been effective in mitigating the results.

In my opinion, a considerable measure of responsibility for this accident rests upon Guard H. E. Chandler. He has a good record and served in France during the War; he was gassed in 1917, and was wounded and made a prisoner of war in March, 1918.

12. Signalman W. Head, however, was primarily responsible, as he failed, at 5.15 a.m., to observe that the mineral train, travelling at 10 to 15 m.p.h., had passed his box incomplete; the result was that he accepted the express three minutes later, at 5.18 a.m.

While visibility may have been restricted by mist, smoke, and steam, the simultaneous passage of the down milk empties train slightly retarded Head's observation of the rear of the mineral train, and possibly made it a little difficult and at longer range; but he did not suggest that his view was indistinct, even though his windows were closed. In fact, the box could not be better situated for observation purposes. Further, so far as he was aware, there were no extraneous lights which might have deceived him, nor did he think that the tail light on the milk empties train could have thrown a misleading reflection in the windows of his box; he had never noticed such a thing. Moreover, the milk empties train was carrying the usual single red tail light, whereas the mineral train carried in addition two red sidelights.

The duty of observing the tail light is simple and this serious lapse in respect of such a fundamental matter of safety on the part of Head, a man of long experience, can only be accounted for as the result of momentary lack of care and concentration. He could not recall an occasion on which a train had passed him incomplete, nor could he remember ever having sent an emergency signal. On the other hand, it is to his credit that he realised his mistake so promptly; he acted efficiently, and, by fortunately preventing the entry of the down empty stock train into the obstructed section, for which Enginemen F. Gould and H. J. Howard are also to be commended, he was instrumental in avoiding further serious consequences.

He is 52 years of age, with 34 years' service; he had acted as a signalman for 25 years, and had served at Shrivenham for 17 years. He was referred to as a very conscientious man with an excellent record.

13. There was an interval of as much as four minutes between the time, 5.18 a.m., when Signalman E. F. Jefferies, of Ashbury Crossing, transmitted the *Out-of-Section* signal for the mineral train to Head, and the time of the entry of the express into the section at Marston Crossing, 5.22 a.m. Had Jefferies also not failed to observe that the mineral train was incomplete when it passed him, and had he warned Head promptly, the latter would have had plenty of time to correct his mistake and the accident would not have happened. I consider that the same measure of responsibility rests upon Jefferies as upon Head.

His omission was aggravated by the facts that he was only dealing with the mineral train at the time, that it passed his box at very slow speed, and that having watched the major portion of it go by, he turned away to attend to a telephone call; further, by his own evidence, even if a tail light had existed, he only attempted to view it after the telephone conversation ceased and then at considerable range. It is significant that he admitted that he would not have failed had he watched the train throughout the whole of its passage. The available evidence does not convince me that the telephone conversation, to which he referred, took place at the time which he suggested.

Signalman Jefferies is 36 years of age, and has 19 years' service, with a good record; he had acted in his present capacity at Ashbury Crossing for nine years.

Remarks and Recommendations.

14. This accident is a reminder of the risks inherent in the failure of coupling apparatus and in the division of goods trains which are not fitted with the continuous brake. The general question of the integrity of drawgear was referred to in my Report upon the accident at Dagenham in December, 1931, in which certain statistics were also given; improvement is to be noted in the number of divisions, as reported by the Companies.

As compared with the averages for the five-year period 1930-34 of 2,639 cases of pulling out or breakage of drawhooks and bars, and of 1,266 cases of breakage of coupling links, the corresponding figures (provisional) for 1935 were 2,226 and 1,003 cases respectively; these accounted for 86·5 per cent. of the divisions of goods trains, railway and privately-owned stock roughly contributing half each. The predominance of failure in respect of drawhooks and bars continues; but these figures are only a small proportion of the yearly totals, if fractures during shunting operations be taken into account.

It was agreed that from the 1st March, 1934, all new drawhooks and bars must be made without welds from steel of 32-38 tons per sq. in. tensile, but that the fitting, as renewals, of drawhooks and bars which were in stock or on order would be permitted up to the 30th June, 1934. Following representations by the Private Wagon Owners' Associations, the latter date was first extended to the 31st December, 1934, and subsequently to the 31st March, 1935. It is specified that drawhooks and bars made of this steel are to be normalised and to withstand a proof load of 30 tons without permanent set, the pull to be from the hook and also from the Gedge slot.

Mr. A. W. Brooks, General Wagon Manager, Messrs. Stephenson Clarke and Associated Companies, Ltd., informed me that his group are complying with the applicable R.C.H. Regulation in respect of all their new construction; he is also taking special steps to test and examine the drawgear of wagons built to the same order as No. 53107. With regard, however, to renewals, such as the hook in question, while steel hooks to the above specification are being supplied for this purpose, a small proportion of the firm's renewals are still being effected, with the approval of the Railway Companies, in wrought iron, welded or otherwise as the case may be.

I understand that while the time limit for using up the stock of drawhooks and bars was extended to the 31st March, 1935, all new drawgear after that date must be of the new design and material. But old drawgear may still be used again, provided that it can be altered in certain agreed ways, and, if the material is mild steel, that no repair is effected by welding, which is only permitted if it is known with certainty that the material is iron.

The question arises whether the general improvement in strength, which is so much desired, will be sufficiently quickly attained, unless actual substitution of the stronger equipment can be carried out before the scrapping of old wrought iron and mild steel equipment becomes inevitable, through wear or failure.

As was pointed out in my above-mentioned Report, the desirable time to consider effecting this betterment would be in conjunction with the seven-yearly overhaul, preparatory to plating as a condition of fitness for continued user. For instance, had the stronger steel hook been provided, in place of the 11-year-old wrought iron hook, when the wagon in question was overhauled and plated in 1932, it seems likely that this division might not have taken place.

On the other hand, if such comprehensive action is not considered to be immediately practicable, at least betterment in the shape of annealing the whole of the drawgear, to maintain, or to restore, the reliability of the weaker material, appears to be desirable forthwith, if this can be effected under proper conditions. It cannot, however, be regarded as a fully satisfactory alternative to the replacement of existing wrought iron and mild steel drawhooks and bars, which in any case should preferably be required after the end of 1937, by which time Private Owners should have completed the first seven-year General Repair Programme.

Having regard to the increasing speed of goods trains, I recommend that consideration of the practicability of some such measures, making for acceleration and betterment in the strength of wagon drawgear, be suggested to the Companies and to the Private Wagon Owners' Associations. Both from the economic and operating aspects, the question is one of considerable importance, and tightening up of the existing R.C.H. Regulations appears to be desirable, in order reasonably to ensure that, within an agreed period, a weak wrought iron drawhook, such as the one in question, will not be in service, and that annealing or normalising will also be included in future as an additional Requirement of a General Repair, preparatory to plating as a condition of continued user.

15. On the other hand, proper observance of Block Regulations would have prevented the results of this breakaway. The accident was not the outcome of forgetfulness, incapacity, or overwork, but of failure on the part of two signalmen to perform a simple and fundamental duty, together with lack of zeal and alertness on the part of a guard. It is true that only the existence of track circuiting *through the Block Section* would have ensured immunity, and it is a matter for serious reflection that the accident is similar in this respect to three out of the 17 which were the subject of Inquiry last year (King's Langley, Welwyn Garden City, and Oakham). But it can hardly be said that the circumstances of this case afford strong justification for protective measures of this kind.

While continuity of track circuiting *through the Block Section* provides the only real safeguard against such human failure as occurred in this instance, and against such effects of the breakaway of vehicles from trains not equipped with the continuous brake (the existence of which on the mineral train would also have prevented this accident), practice in this country has primarily, and rightly, been based upon the policy of *Local* installation; this policy is particularly illustrated by the *train-waiting* track circuit in rear of the home signal, the occupation of which controls the block instruments, which are in many cases interlocked with the starting signal in rear.

The statistics for the five years 1930-34 afford confirmation. Out of 65 accidents of all characters, into which Inquiries were held during that period, 14 would probably have been prevented by equipment of this kind, but in all of these 14 cases the result would have been achieved by *Local* installation (six by a *train-waiting* track circuit; eight by track circuits elsewhere within interlocking limits), as opposed to installation right *through the Block Section*.

The track circuit in rear of the home signal at Shrivenham is an example of what is being done in this respect. When occupied, it prevents *Line-Clear* being transmitted on the block instrument. The wagons probably came to rest before the express was accepted at 5.18 a.m.; but they failed to reach this track circuit by only 180 yards, after having run for more than 1¼ miles. Had speed at the time of the division been only a trifle higher, they would have occupied this track circuit, and the express could not have been accepted. Perhaps this is the best illustration of the unfortunate circumstances in which this collision took place, marring the Company's outstanding record of immunity from passenger fatality in train accidents.

Finally, it is desirable to record the fact that the valuable system of intermittent Automatic Train Control, which the Company has installed over nearly 2,300 track miles of their main lines, had no bearing upon this accident; it is also

of interest to note that apparently the first cost of track circuiting (Direct Current) *through the Block Section* (as opposed to *Local* installation), would not greatly differ from that of this system of Automatic Train Control (including locomotive equipment), averaged on the same basis of total track mileage.

16. The lack of synchronisation of the two signal box clocks at this station has been referred to. It appears to have been exceptional, but previous records for the express also disclosed considerable and varying differences; on this occasion the difference amounted to four or five minutes. As already stated, the Company's officers were at first inclined to think that Shrivenham was one minute slow and Ashbury Crossing three minutes fast; but it was finally concluded that the former was two minutes slow and the latter at least two minutes fast.

Ashbury Crossing depended upon Shrivenham for the daily time signal at 11.0 a.m.; but apparently the signalman at Ashbury Crossing, who was concerned in this accident, was neither making a practice of recording the signal nor of checking his clock when he was on the 6.0 a.m.—2.0 p.m. turn of duty. On such occasions, the necessary correction was thus made later in the day when the records sometimes indicated inaccuracy of as much as four minutes fast. This had not been observed, but the Stationmaster only examined the register once a month and did not cross-check with the Shrivenham records. To maintain a high standard of efficiency in this respect, the following points appear to be worthy of notice :—the method of transmission and the accuracy of the daily time signal; the conscientious adjustment of clocks, noting the error, on receipt of the signal; and the careful supervision and checking of registers by the Inspector and/or Stationmaster concerned.

17. With regard to the behaviour of the rolling stock in this collision, the outstanding feature was the fact that the body of the leading coach of the express, with perhaps 34 passengers in it, was partially hurled down the bank and practically turned upside down, the rear end becoming badly smashed, though the doors at the front end were still capable of being opened. The older all-timber body of the second coach collapsed. There was no fracture of screw couplings, but those on the first vehicle became unhooked and allowed these two coaches to be thrust aside; it is a matter for conjecture whether the Buckeye coupler (which this Company commenced to experiment with in 1922, decided to remove in 1929, and ceased to use in 1931) would have afforded more effectual protection, as it did recently at Welwyn Garden City, in view of the overturning of the engine in this case, its stoppage in 87 yards, and the much more rapid retardation of a heavier train.

There seems, however, to be little doubt that the Company's method of construction contributed to the comparatively low incidence of casualty, and, in view of the remarkable way in which the first coach survived, it is also impossible to say definitely whether the casualties therein would have been lessened by marshalling this vehicle behind the brake van. But there is no doubt as to the general preference in this respect, and I understand that, with rare exceptions, the brake van is next the engine when this train leaves Swindon. On the date in question, however, the coach concerned came from the Torquay branch and was marshalled in front when the engines were changed at Newton Abbot. There are at present no instructions to prohibit this; but the Company's officers informed me that, so far as it is practicable, steps will be taken in future to retain a brake van as the leading coach of long-distance trains.

18. The enginemen of the mineral train did not look back to observe the sidelights of the brake van, when the train was entering (5.15 a.m.) the goods running line at Ashbury Crossing. They were under no specific obligation to do so, but had they taken this precaution, as they did when passing Marston Crossing box, they should have become aware of the division.

Travelling at slow speed, the train could have been quickly stopped; there were no less than seven minutes available in which to do this and to advise the signalman to prevent the entry (5.22 a.m.) of the express into the section at Marston Crossing. I think it would be well to suggest to the Companies that consideration might be given to the practicability of strengthening Rule 126 (viii), for instance, by special reference to the importance of looking back while passing signal boxes.

19. My attention has again been drawn in correspondence to the use by the guard of Flares and/or Verey Lights, as an additional means of protecting an obstruction in the section during hours of darkness. The suggestion was referred to in my Report upon the accident at Dinwoodie in 1928, after which extensive tests were carried out on the Great Western Railway, on behalf of the Companies, and full consideration was given to the whole question.

The conclusion was reached that, having regard to its limited utility and to other disadvantages, the provision of such additional equipment was not justified. In view of the failure of the guard, the circumstances of this accident evidently afford no grounds for altering existing procedure, which is based upon the use of the detonator, nor for thinking that the devices referred to would have had preventive effect.

I have the honour to be,
Sir,
Your obedient Servant,
A. H. L. MOUNT,
Lieut.-Colonel.

The Secretary,
Ministry of Transport.

APPENDIX I.

PARTICULARS OF DAMAGE TO ROLLING STOCK OF 10.30 A.M. SPECIAL COAL TRAIN:—

Vehicle.	*No.*	*Owner and Description.*	*Damage.*
48th	53107	G.L.M. 12-ton Coal Wagon	One long Gedge drawbar hook broken.
49th	2961	Stephenson Clarke. 20-ton Coal Wagon	Metal of bearings fractured, and one end door locking bar broken.
50th	4226	Stephenson Clarke. 12-ton Coal Wagon	1 Headstock broken. 2 Buffer castings broken. 1 Axleguard broken. 1 end door broken. 1 Solebar split.
51st	234	Wallace Spiers. 10-ton Coal Wagon. Registered No. 58958 L. & N.W., 1915.	Completely Smashed.
52nd	0841	Stephenson Clarke. 10-ton Coal Wagon. Registered No. 33808, G.E.R., 1907.	Completely smashed.
53rd	6312	Stephenson Clarke. 12-ton Coal Wagon. Registered No. 55482, G.W.R., 1923.	Completely smashed.
Brake Van	56923	G.W.R. 24-ton.	The verandah end, which was trailing, was destroyed, and the wheels were torn from the under frame.

Formation of, and particulars of damage to, 9.0 p.m. Express, Penzance to Paddington:—

Engine No. 6007.

Frames.—R.H. main frame, front end, bent (not cracked), standing off inside cylinders ⅜ in., wants rebolting. R.H. footplate wants renewing, front end and back. R.H. front corner brackets bent. R.H. hanging bar, bent front and back. R.H. motion plate bent. L.H. main frame, front end, bent and broken. L.H. corner bracket missing. L.H. hanging bar, front end, bent. L.H. motion plate, outside, bent. Buffer bar, box angle iron, angle irons and screw connection, broken.

Cylinders.—All cylinders good. R.H. back cover, broken.

Valve Gear.—R.H. valve spindle, bent.

Reversing Gear.—Reversing screw and box, bent, will not reverse.

Cab.—Weather board, cab sides, leg plates, windows, cab handrails, pillars and T. irons, smashed. 4 cone, handrails, top feed pipes R.H. side, all smashed.

Boiler Mountings.—Good.

Sand Gear.—R. trailing sandbox, smashed.

Brake Gear.—Brake hangers, cross stays and rods, smashed.

Bogie.—Both frames bent. Leading cross stay and life guard missing. R.H. bogie centre controlling spring and case smashed. L.H. inside T. springs and hangers all bent. Bogie centre pin casting broken in two webs only.

Springs.—Engine springs good. Spring hanger brackets and spring hangers on L.M.D. bent.

Miscellaneous.—Damper gear and cylinder cock gear on footplate damaged. Cylinder cock gear and cocks on R.H. outside cylinder broken off.

Tender No. 2572.—All axleboxes broken. Brake rods, stays and hangers bent. Brake column broken and shaft bent. One brake hanger bracket missing. Draw gear side and centre links bent. Four handrails and two lamp irons back of tender bent. Tank water indicator gear column broken. Water pick-up scoop broken. Leading and trailing dragboxes damaged. Number plate broken. Intermediate buffers bent. Vacuum pipes damaged trailing end. Vacuum drip trap plate bent. Toolboxes badly damaged. Draghook bent. Middle wheels slightly out of gauge.

Back and front footplates broken and buckled. Right hand side footplate broken and buckled, back end. Two toolbox angle irons broken, right side. Coal door and coal door top broken, right side. Coal door wing broken, right side. Coal plate bent front end, right side. Shovel plate broken. Footboard supports broken. Tank, back end, badly bent, and broken, right and left sides. Tank, back end, inside plates and top angle irons broken.

Rolling stock, all bogie vehicles, screw coupled, electrically lighted:—

Coach No.	*Class and Particulars.*	*Damage.*
4000	Corridor Third. 8-wheeled. Tare 35 tons 5 cwt. Built 1921. Length 73 ft. 0 in. Underframe, steel. Body, wood framing and steel panels; roof of wood.	Wrecked.

APPENDIX I—*continued.*

Coach No.	*Class and Particulars.*	*Damage.*
1203	Newspaper and guard's van. 12-wheeled. Tare 35 tons 0 cwt. Built 1910. Length 73 ft. 1 in. Underframe, steel. Body and roof, wood framing and wood panels.	Wrecked.
9088	First Sleeper. 12-wheeled. Tare 42 tons 13 cwt. Built 1929. Length 63 ft. 6½ in. Underframe, steel. Body and roof, wood framing and steel panels.	Both ends of body driven in; leading end, lavatory and corner extensively damaged; mirror on partition, No. 6 compartment, broken; drop window, No. 5 compartment, broken; large window on corridor side centre of coach broken; and filter broken. 1 broken buffer guide. 3 bent buffers. 1 badly bent headstock. 1 slightly bent headstock. 1 frame diagonal slightly bent. 1 step iron bent. 1 gangway angle iron face plate badly bent, canvas damaged. 1 gangway angle iron face plate slightly bent. 4 gangway suspension bolts bent. 2 strained screw couplings. 1 flexible steam pipe missing. 1 flexible vacuum pipe missing. 1 bogie headstock bent. 1 bogie diagonal slightly bent. 12 bolster suspension bolts bent. 1 axlebox top broken. 8 axlebox bottoms broken. 3 brake bow girders bent. 1 brake pull rod bent. 4 brake safety hangers bent. Battery box broken and iron supports bent. 3 glass cells broken. Several wheel tyres slightly bruised.
9073	Third Sleeper. 8-wheeled. Tare 35 tons 5 cwt. Built 1929. Length 63 ft. 6½ in. Underframe, steel. Body and roof, wood framing and steel panels.	Leading end of body driven in. 4 bent buffers. 1 broken buffer guide. 2 slightly bent headstocks. 1 strained screw coupling. 1 gangway front angle iron bent. 2 snspension bolts bent. 1 slightly bent cross truss angle iron. 1 brake bow girder bent. 2 bogie tie rods bent. 1 brake rod safety hanger bent. 1 flexible vacuum pipe broken. 1 flexible steam pipe broken. 1 regulator box slightly damaged. 1 glass cell broken. 1 spring link (broken C.I. cup). 2 slightly bent bolster suspension bolts. Several wheel tyres slightly bruised.
4606	Brake Third. 8-wheeled. Tare 35 tons 9 cwt. Built 1923. Length 73 ft. 6½ in. Underframe, steel. Body and roof, wood framing and steel panels.	2 bent headstocks (slight) on underframe. 2 bent buffers. 1 bent drawbar. 1 coupling screw bent. 4 buffer pads broken.
7756	Composite. 8-wheeled. Tare 34 tons 3 cwt. Built 1912. Length 73 ft. 1 in. Underframe, steel. Body, wood framing and steel panels; roof of wood.	2 bent buffers. 1 bent drawbar. 1 coupling screw bent.

APPENDIX I—*continued.*

Coach No.	*Class and Particulars.*	*Damage.*
9065	First Sleeper. 12-wheeled. Tare 42 tons 13 cwt. Built 1929. Length 63 ft. 6½ in. Underframe, steel. Body and roof, wood framing and steel panels.	1 large window broken. 2 slightly bent headstocks on underframe. 2 bent buffers. 1 bent drawbar. 1 coupling screw bent.
9070	Third Sleeper. 8-wheeled. Tare 35 tons 5 cwt. Built 1929. Length 63 ft. 6½ in. Underframe, steel. Body and roof, wood framing and steel panels.	1 door off its run. 2 bent headstocks (slight). 2 bent buffers. 1 bent drawbar. 1 coupling screw bent.
3484	Brake Third. 8-wheeled. Tare 32 tons 13 cwt. Built 1906. Length 73 ft. 5 in. Underframe, steel. Body and roof, wood framing and wood panels.	1 coupling screw bent.

APPENDIX II.

BROKEN DRAWBAR HOOK FROM G.L.M. WAGON NO. 53107—
ACCIDENT AT SHRIVENHAM, 15/1/36.

I give below the results of my examination of the above broken drawbar hook :—

Description of fracture.

The hook broke in the position shown in the attached sketch in a plane at an angle of approximately 60 degrees to the axis of the drawbar, the fractured surface having the appearance of a typical shock fracture. The cross-sectional area at the point of fracture was 5.9 square inches.

The whole of the face of the fracture was bright and had a coarsely crystalline appearance with the exception of a portion measuring ½ in. by ⅜ in. which extended inwards from the surface at the top of the hook. This area was covered with an oxide film and appeared to be a flaw which had been in existence for a considerable time and was produced probably during manufacture of the hook.

Chemical Analysis.

Analysis of the material adjacent to the fracture gave the following results :—

Carbon ...	...	0·02 per cent.
Silicon ...	...	0·127 per cent.
Manganese	...	0·08 per cent.
Sulphur ...	...	0·016 per cent.
Phosphorus	...	0·276 per cent.

These results prove the material to be wrought iron. The proportion of phosphorus present is rather high, but not higher than is found frequently in iron having good physical properties.

Physical Tests.

Test pieces cut from the hook as close as possible to the fracture and in a direction parallel to the axis of the drawbar were tested with the following results :—

Breaking stress, tons per sq. inch on 0·25 sq. inch area	21·6
Elongation on 2 inches, per cent.	31·5
Contraction of area, per cent.	39·2
Yield Point, tons per sq. inch.	11·6
Ratio of Yield Point to Ultimate Stress, per cent.	53·7
Izod Shock Test, foot lb.	10·2 10·2
Brinell Hardness Number	118

A machined test piece measuring 1½ in. by ¾ in. by 7 in. cut from the hook in a direction parallel to the axis of the drawbar broke when bent cold through an angle of 80° over a round bar 2½ in. in diameter.

The results of the tensile test are satisfactory for wrought iron of good quality. The Izod figure, however, is very low, being less than a third of that given by good quality iron. The result of the bend test is poor.

Macrostructure.

A sulphur print prepared from a transverse section adjoining the fracture showed the characteristic uneven distribution of sulphides normally encountered in wrought iron. In no part was there any indication of unduly high sulphur segregation.

APPENDIX II—*continued.*

Macro-etching revealed lack of homogeneity of the material and the presence of wide boundaries containing large slag inclusions between adjacent areas of iron having different grain sizes.

Microscopic Examination.

The microscopic examination of polished and etched sections showed that the metal contained a considerable amount of slag which was present in rather large masses unevenly distributed throughout the material. The shape, mass and distribution of these slag inclusions indicated that the metal had not been subjected to sufficient forging to produce the degree of homogeneity which is desirable.

The grain size of the iron varied in different parts of the section, but was generally very large and suggests that the metal was overheated during forging.

Conclusions.

The results of my examination indicate that the wrought iron of which the hook was made was of fair quality chemically, but that it had been insufficiently worked to produce homogeneous material free from coarse slag inclusions.

The hook appeared to have been heated to a high temperature during forging which resulted in the production of a very coarsely crystalline structure, to which the poor shock-resisting property of the metal, as shown by the low results of the Izod Test, is chiefly due.

The existence of the small defect in the hook, to which reference is made in the description of the fractured surface, was, in my opinion, a contributory cause of the failure, resulting in the production of "notch brittleness" at the low temperature existing at the time the fracture occurred.

R. W. DAWE.

APPENDIX III.

RULES AND REGULATIONS APPLICABLE TO GOODS GUARDS.

148.—(*b*) The Guard of a goods train must keep a good look-out and, should he see any reason to apprehend danger, he must make every effort to attract the attention of the Driver.

If there is any Danger to a train on an adjoining line, the Guard must, should his train pass a signal box, exhibit to the Signalman a red hand signal waved slowly from side to side, and the Signalman must, on receiving this signal, act in accordance with Block Regulation 17.

(*d*) In the case of trains not fitted with the continuous brake, the Guard must, unless special instructions are issued to the contrary, always apply his brake as soon as he becomes aware that the Driver is applying the engine brake.

RULES AND REGULATIONS APPLICABLE TO ENGINEMEN.

126. The Driver and Fireman MUST:—

(viii) observe signal boxes when passing them and look back frequently during the journey to see that the whole of the train is following in a safe and proper manner.

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