MINISTRY OF TRANSPORT

RAILWAY ACCIDENTS

REPORT ON THE DOUBLE COLLISION which occurred on 8th October 1952 at HARROW AND WEALDSTONE STATION in the LONDON MIDLAND REGION BRITISH RAILWAYS

LONDON: HER MAJESTY'S STATIONERY OFFICE
1953

FIVE SHILLINGS NET

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MINISTRY OF TRANSPORT,
Berkeley Square House,
London, W.1.

12th June, 1953.

SIR,

I have the honour to report for the information of the Minister of Transport, in accordance with the Order dated 8th October 1952, the result of my Inquiry into the disastrous double collision which occurred at about 8.19 a.m. on that day at Harrow and Wealdstone station, about 11½ miles from Euston, on the Western Division six track main line in the London Midland Region, British Railways.

The two trains concerned in the primary collision were the 7.31 a.m. Up local passenger train from Tring to Euston, comprising nine non-corridor bogie coaches hauled by a 2–6–4 type tank engine, and the 8.15 p.m. Up express passenger train from Perth to Euston, which consisted of 11 bogie vehicles, including four sleeping cars and three vans, hauled by a tender engine of 4–6–2 type. The third train, which ran into the wreckage of the first collision was the 8.0 a.m. Down express from Euston to Liverpool and Manchester, consisting of 15 bogie vehicles, including four vans at the rear; this train was double-headed, with a 4–6–0 type engine in front, and a 4–6–2 type engine attached to the coaches.

The local train had crossed from the Up Slow to the Up Fast line at the country end of the station, and had stopped, as booked, at the Up Fast (No. 4) platform. It had been standing there for about 1½ minutes and the brakes had been released when it was struck heavily at the rear by the Perth express which had passed the colour light distant signal at caution and two semaphore signals at danger in patchy fog and was travelling at 50–60 m.p.h. on the Up Fast line; the express had burst through the trailing points of the crossover from Up Slow to Up Fast, as they were still locked reversed by the Up Fast Starting signal ahead which had been cleared for the local train to proceed on its journey.

The resulting wreckage was spread across the adjacent Down Fast line on which the Liverpool express was approaching at not much less than 60 m.p.h., and the leading engine of this train struck the derailed engine of the Perth train a second or two after the first collision. Both of the Liverpool train engines were diverted to the left across one of the platforms and were overturned foul of the Up Electric line close to the No. 2 signal box which controls the Electric lines only. The current was removed from the conductor rails of the Up line by the resulting short circuit, and from the Down line by the prompt action of the signalman; an Up electric train from Watford was stopped well clear by the loss of current, and by the automatic reversal of the Up line Home signal to danger.

The damage to the three express engines and the destruction of rolling stock by the two collisions at high speed were altogether exceptional. Three passenger coaches of the local train, three of the Perth train and seven of the Liverpool train, as well as two bogie vans and a kitchen car, were demolished or very heavily damaged; 13 of these 16 vehicles were compressed into a compact heap of wreckage about 45 yards long, 18 yards wide and 30 ft. high, completely burying the engine of the Perth train as it lay foul of the Down Fast line. One end of the wreckage was jammed under the station foot-bridge, a steel girder of which was torn away.

It was inevitable that the casualty list was very great, particularly as the local train was crowded, and indeed the death roll has only once been exceeded in an accident on the British railways.* I much regret to record that 112 persons altogether lost their lives; 98 passengers and four railway servants on duty were killed outright, including the driver and fireman of the Perth express and the driver of the leading engine of the Liverpool express, and 10 passengers died later in hospital from their injuries. Of the 108 fatalities to passengers, there was evidence that 64 occurred in the local train, 23 in the Perth train and 7 in the Liverpool train; the remaining 14 were not located, but it is probable that some passengers who were waiting on the island platform between the Down Fast and Up Electric lines were caught by the derailed engines of the Liverpool train.

In addition, 157 persons were conveyed to hospitals in the neighbourhood, where 84 passengers were detained, many with very serious injuries. Four railway servants on duty were also detained in hospital, including the fireman of the leading engine of the Liverpool train and the driver and fireman of the second engine; these three men all had remarkable escapes when their engines were overturned. Apart from those who received hospital treatment, 183 persons sustained minor injury or shock.

No less than 36 of the passengers who were killed and many of the injured were members of the Railway staff who were travelling to work in London, the great majority of them in the London Midland Region offices at Euston.

Telephone calls for assistance were sent out at once by several members of the station staff, and there was an immediate response from the Metropolitan Police and all the local emergency organisations. Railway staff, who were working at or near the station, and railwaymen and other uninjured passengers in the local train also made an immediate start on the work of first aid and rescue, in the organisation of which a notable part was taken by Mr. L. Rowlands, of the Operating Superintendent's department at Euston, who was in the fourth coach from the rear of the local train and was severely shaken. He also made sure that all railway departments were advised of the accident without delay.

The first ambulance and doctor arrived within three minutes of the collision at 8.22 a.m. and Police and the first Fire Brigade at about the same time. From 8.23 a.m. onward, ambulances, doctors, nurses, additional fire brigades and police arrived in increasing strength, and a medical unit of the United States Air Force under Lieutenant Colonel Weideman gave valuable service. The fire brigades extinguished a few minor fires in the wreckage before they became at all serious, but their main contribution lay in the

* The double collision at Quintinshill, Gretna, on 22nd May, 1915, in which 227 persons were killed.

knowledge and skill which they applied to the extrication of the injured. Others who gave their help included priests and ministers of several denominations and members of the Salvation Army and the Women's Voluntary Service, and offers of assistance were accepted from local residents and from engineering firms in the neighbourhood who lent staff and equipment.

The first loaded ambulance left the site at 8.27 a.m. Thereafter there was a continuous stream of ambulances to the hospitals until 10.30 a.m., and by 12.15 p.m. the great majority of the injured had received first aid attention and had been conveyed to hospital. Two further seriously injured cases were removed at 2.30 p.m., but it was not until 1.30 a.m. on the following morning, 9th October, that there appeared to be no chance at all of anyone being found alive in the debris of the coaches.

Generally, the relief work was carried through with quiet efficiency under the difficult conditions imposed by the magnitude and complexity of the wreckage and the constriction of the site. Many well deserved public tributes have been paid to all who were concerned in it, but I should also mention that the smooth working of the arrangements as a whole was due in no small measure to the general direction of Mr. S. G. Hearn, Operating Superintendent, London Midland Region, who set up a control room on the platform on his arrival at 9.5 a.m., for which very complete temporary telephone services were promptly organised by Mr. S. Williams, the Signal and Telecommunications Engineer; he also was travelling in the fourth coach from the rear of the local train and his compartment was damaged. Mr. F. W. Abraham, the Motive Power Superintendent, who was in the same compartment, took immediate steps to get heavy cranes to the site and then continued to direct the work of the breakdown gangs throughout the day, in conjunction with the District Superintendent, Mr. L. W. Cox, who was in immediate charge of the operating side of the work.

The blockage of this main route to the North was complete. Although the Up and Down Slow lines were obstructed by light debris only, a temporary walk-way had to be maintained across them for some time for the evacuation of the casualties to the ambulances in the goods yard on the east side, and they were afterwards used for working the cranes. The 30-ton crane from Willesden arrived at 9.40 a.m. and was manoeuvred into position at 10.45 a.m. and it was followed at 11.28 a.m. by the 50-ton crane from Rugby which was in position at 1.25 p.m., and the 36-ton crane from Kentish Town, which had arrived at 12.40 p.m. was brought into use at 3.35 p.m. The 50-ton crane from Crewe arrived at 9.55 p.m. and at 3.45 p.m. on the following day, 9th October, the 46-ton crane from Old Oak Common, Western Region, was used to replace the Kentish Town crane which had developed a defect.

The prolonged task of clearing the wreckage was carried through with determination by the breakdown gangs, who worked untiringly with the minimum of rest and relief until late on Saturday, 11th October, but there was some delay to the lifting operations, especially in their earlier stages, owing to the care which was needed in the search for the injured and the recovery and identification of the bodies. It became possible to work the cranes end on to the wreckage from the Fast lines on the evening of 8th October, and the Up and Down Slow lines, which were undamaged, were opened to traffic under caution at 5.32 a.m. on 9th October. The complete interruption of the route had thus lasted for 21¼ hours.

In the meantime, the leading engine of the Liverpool train had been rerailed and removed to the sidings, but the second engine of this train could not be disposed of until 2.15 a.m. on Friday, 10th October. After that the electric lines still had to be used for some time by the cranes working on the coaches and for disposal of the debris, and it was not possible to open them to traffic until 4.30 a.m. on Saturday, 11th October, after a slip connection had been renewed.

The engine of the Perth train could not be recovered from the Down Fast line until the mass of wreckage which covered it had been lifted and the damaged girders of the footbridge cut away. It was finally drawn clear and placed in the sidings at 4.8 p.m. on Saturday, 11th October. After repairs had been carried out to the permanent way, which was not very extensively damaged, the Up and Down Fast lines were restored to traffic by 8.0 p.m. on Sunday, 12th October. Normal working was then resumed, though a speed restrictions was necessary on both the Fast lines for the reconstruction of the severely damaged platforms. A temporary station footbridge was available by the evening of 12th October, and a new permanent span was brought into use on 9th November. The speed restriction on the Fast lines was withdrawn at 5.0 p.m. on 14th October.

The dislocation of traffic was widespread, but full use was made of alternative routes and most of the Euston passenger services were dealt with at St. Pancras and Paddington, travelling via Nuneaton and Leamington respectively. Others were terminated and started at Watford, and a few Down passenger trains were sent from Euston via Willesden and Acton Wells to use the Midland division route as far as Nuneaton. Many special connecting services were run. The position was eased when the Slow lines were opened to traffic early on 9th October, but some diversions were still necessary until the Fast lines could be used again on 12th October.

Many freight services had to be cancelled or diverted with consequent reaction on the working of Willesden and other yards and goods stations, but with the co-operation of other Regions, diversions and improvised arrangements were effective in preventing serious congestion, and the traffic position was normal by Monday, 13th October. On the electric lines, trains from Watford were terminated at Hatch End and from the London direction at Wembley, and a bus service was arranged by the London Transport Executive between these two stations. In view of the good alternative transport facilities in the Harrow area, there was no demand for special arrangements for the uninjured passengers to continue their journey.

Fog was widespread through the night and early morning in the Midlands and the Northern Home Counties. At the time of the accident it was clearing fairly quickly at Harrow as the sun broke through, and the visibility around the station varied from about 200 yards to 300 yards or more, though it was probably more restricted in the open country by the Up distant signals. There was very little wind.

I. Description of Trains and Effects of the Two Collisions

1. The composition of the three trains, which were screw coupled throughout, is shown in tabular form by Appendix A. It will be noted that the nine non-corridor coaches of the local train comprised seven ordinary thirds and two brake thirds ; one of the two brake compartments was next to the engine, and the other was at the trailing end of the 7th coach and not at the extreme rear. The train was more crowded than usual, as the next local service to London had been discontinued temporarily on account of the extensive track and signalling improvements which were in progress at Euston ; there were approximately 800 passengers in the 74 compartments.

The four leading coaches and the brake third marshalled 7th had steel panelled bodies on hard wood framing, and the bodies of the 5th, 6th, 8th and 9th were wholly of wood. All the underframe members were of steel except for the wooden headstocks of the 9th coach which was 35 years old. All except the 8th and 9th were fitted with long stroke shock absorbing buffers of London Midland and Scottish Railway design. The total weight of the coaches was 246½ tons and they were hauled by a 2–6–4 type two-cylinder tank engine, No. 42389 of the 4MT class, weighing 86¼ tons in working order ; it was driven from the right hand side as it was running, bunker first. The total weight of the train was thus 332¾ tons and its total length was 194 yards. As has been stated, the brakes were off when the collision took place.

2. The 11 bogie vehicles of the Perth train were marshalled with a Western Region milk van leading followed by a passenger train brake van ; after that there were four corridor passenger coaches and then four sleeping cars with a brake van at the rear. There were approximately 85 passengers in the train.

The two leading vans had wooden bodies, and the remaining vehicles had steel panelled bodies on hard wood framing. The underframes were of steel throughout, and shock absorbing buffers were fitted to all except the leading van. The total weight of the vehicles was 364 tons and they were hauled by a 4–6–2 type four-cylinder engine, No. 46242, Class 8P, weighing 161½ tons in working order with its tender ; it was driven from the left hand side. This engine was one of the most powerful in the country, with 6 ft. 9 ins. coupled wheels and 40,000 lbs. rated tractive effort, and the load of 364 tons was thus relatively light. The steam brake was in operation on the coupled and tender wheels, applied by the same handle as the vacuum brakes of the train, and the combined brake power was 69 per cent. of the total weight of 525½ tons ; all except one of the vehicles were fitted with direct admission valves which give a more rapid response of the train brakes to the driver's application. The total length of the train was 255 yards.

3. The 15 corridor bogie vehicles of the Down Liverpool train were marshalled with a brake third in front, with its brake compartment next to the engine, and this was followed by six other passenger coaches; the next vehicle was a kitchen car, and after that there were four passenger coaches, with four brake vans in rear. There were approximately 200 passengers in this train.

All the vehicles had steel underframes and all except the 14th were fitted with shock absorbing buffers. The bodies of the leading three coaches and of the 7th, 8th (kitchen car), 9th and 10th were steel panelled on hard wood frames, and the four vans at the rear had wooden bodies. The 5th coach had an all-steel body, and the 4th and 6th, as well as the corridor third brake marshalled 11th, were constructed to the new British Railways standard design with strengthened underframes, to which the all-steel body structures were welded. The total weight of the coaches was 444¼ tons.

The leading engine was No. 45637 of the 6P class with 4–6–0 wheel arrangement and three cylinders, weighing 133¼ tons with its tender, and the train engine was No. 46202 of the 8P class with 4–6–2 wheel arrangement and four cylinders, weighing 159¾ tons with tender; both these engines were driven from the left hand side. Engine No. 46202 was of similar power to the engine of the Perth train, No. 46242, though the boiler was rather smaller; the 15 coach load of 444¼ tons was within its rated load capacity without assistance, and No. 45637 had been attached in front to work back to its home shed. The steam brakes on the coupled and tender wheels of both engines were controlled from the leading engine by the vacuum working the brakes on all wheels of the coaches. Direct admission valves were fitted to 10 of the 15 vehicles and the combined brake power was approximately 75 per cent. of the total weight of 737¼ tons. The total length of the train was 350 yards.

4. Owing to the very short interval between the two collisions, the precise amount of destruction and damage which was caused by each of them could not be assessed. Certain features, however, were clear, and the following brief summary should be read in conjunction with Fig. 1 of the attached plans which shows the positions of the engines and of some of the vehicles as they finally came to rest, and with the photographs.

The Local train was occupying the whole of the Up Fast platform, and its brakes had been released. The brakes of the Perth train had been applied at the very last moment, but they had not taken appreciable effect when its engine struck the rear of the local train at or about the top of the platform ramp, telescoping the last three coaches into a length of little more than one and driving the train forward as a whole for about 20 yards. The underframe of the rear coach, No. 14281, was severely crumpled at its trailing end and was thrust forward above the underframe of the next coach ahead, No. 15202, and below the underframe of the next ahead again, brake third No. 21183. The bogies of these three coaches were driven together and the three distorted underframes were flung aside to the left, and came to rest in an irregular heap on the Up Fast platform, as shown by photograph 6.

The wooden bodies of the two crowded rear coaches, Nos. 14281 and 15202, were shattered as they were telescoped together, and it is remarkable that some passengers in them escaped with comparatively slight injuries. The brake compartment at the trailing end of No. 21183 and the two passenger compartments next to it were demolished, but the remaining passenger compartments of this coach kept their form,

although this part of the body was torn from the underframe as a whole and overturned to the left on to the platform. The leading end of this coach came to rest under the station footbridge and abreast of the Perth train engine, which was found to be standing on the alignment of the *Down* Fast line after the overlying wreckage had been cleared.

Except for the two rear compartments of the next coach ahead, No. 11254 (photograph 10), the six leading coaches of the local train sustained no severe structural damage and were eventually drawn forward on the Up Fast line by the undamaged tank engine, after a pair of wheels of No. 11254 had been rerailed. The panels on the right hand side of No. 11254 were scraped and broken by some of the coaches of the Liverpool train as they became derailed, and Mr. Williams, who was in this coach (see page 2), told me that this scraping took place a second or two after the last of three distinct shocks from the rear, which he suggested were caused by the successive destruction of the three coaches behind him by the engine of the Perth train.

5. A severe depression in both the 113 lbs. flat bottom rails of the Up Fast line about 5 yards beyond the platform ramp showed that the engine of the Perth train, No. 46242, must have dealt a severe vertical blow to the track as it plunged into the local train (Fig. 1—inset B). It was derailed to the right on to the Down Fast line and came to rest, more or less upright, about 78 yards beyond the first point of impact (Fig. 1—inset A). The tender was overturned to the left, and had crushed the left hand side of the engine cab as it was slewed round at right angles to the tracks. From the very heavy damage which the engine sustained at the front, particularly at the right hand side, it was clear that it had been struck directly by the leading engine of the Liverpool train, which was correspondingly damaged. No one can be sure whether it was still moving ahead at the time, but it is possible that it was stopped in this way from penetrating into the 6th coach of the local train, No. 11254, with which it was found in close contact.

Photograph 1 shows the right hand side of engine No. 46242 after it had been rerailed and placed in a siding; nothing more than the twisted rods and other motion parts had been cut away. The main frames were severely buckled, and it will be noted that the front end of the right hand frame plate was torn away from the inside cylinder casting and that the right hand outside cylinder and steam chest were smashed. The crushing of the comparatively light smoke box plating had saved the boiler from serious structural damage, though the front tube plate was bent. Three of the main steam pipes in the smoke box were broken. Pressure in the boiler must have been released when one of the safety valves and a top feed clack box casting were broken off, and the water had been blown away through a displaced mud hole door on the firebox, with the result that the crown sheet was burnt. The brick arch was undamaged.

Photograph 2 illustrates the damage which occurred between the engine and the tender which was probably responsible for the fatal injuries to both the enginemen, and photograph 3 shows the cab fittings; none of their steam joints was broken and the two water gauge glasses were intact, but the drain pipe and cock of the left hand water gauge had been torn away and must have released some steam and hot water into the cab. The extensive damage to the tender included the buckling of both the main frames and the bursting of the tank, and all the water was lost. I refer later to the position in which the engine controls were found.

6. The derailment and sudden stoppage of the heavy engine of the Perth train caused the leading two vans and the following three passenger coaches, Nos. 1799, 26896 and 4469, to pile up behind and above it, and their distorted underframes and bogies, together with some of the bogies of the local train, were compressed into a mass of wreckage about 100 ft. long covering the Up and Down Fast lines between the platforms. As will be seen from photographs 7 and 8, none of the carriage bodies was recognisable as such, and it may well be that their destruction was completed as some of the leading coaches of the Liverpool train overrode them. Severe damage to the Perth train stopped short behind the 5th coach. Damage to the 6th coach, No. 1517, was little more than superficial and its leading bogie only was derailed; the four sleeping cars marshalled 7th–10th and the brake van at the rear remained on the rails intact except for the displacement of a few internal fittings.

7. The leading engine of the Down Liverpool train, No. 45637, was diverted to the left when it hit the engine of the Perth train under the footbridge, and it ploughed its way across the platform between the Down Fast and the Up Electric lines taking the train engine, No. 46202, with it. No. 45637 came to rest on its left hand side across the Electric lines at an angle of about 30°, approximately 75 yards from the point of impact, and No. 46202 was overturned to the left at the edge of the platform—See photographs 7 and 9.

Except for the boiler, Engine No. 45637 was practically reduced to scrap. The bogie was wrecked and its component parts scattered, and the buffer beam and the frames were folded back as far as the leading coupled wheels. All three cylinder castings were smashed, and the tyre was broken off the right hand leading coupled wheel centre, which itself was fractured in several places. There was also very heavy damage at the rear end as the tender was driven into it, as is shown by photograph 4. Photograph 5 shows the remains of the engine as it was eventually recovered after the twisted framing at the front end had been cut away. The tender tank was torn from the main framing and turned upside down, and one of the distorted side frame plates was found underneath engine No. 46202 as it lay on its side, see photograph 9.

The structural and other damage to engine No. 46202 was also severe and extensive and included the buckling of the main frames and the fracture of the bogie centre pivot casting; the frame of the rear carrying truck was also broken. The tender, which was still coupled to the overturned engine, was more or less upright on its wheels on the remains of the platform; it was heavily damaged at the rear, presumably as the leading coach was driven against it, and its main frames were buckled. On the whole, engine No. 46202 did not suffer so severely as the other two which had taken the main shock.

8. The leading brake third of the Liverpool train, No. 26856, followed the two engines *to the left* on to the *Down Fast* platform with its bogies still below the underframe—see photographs 7 and 9; the

right hand side of its body was ripped out by the underframe of the following passenger coach, No. 4813, the body of which was destroyed. The remains of the underframe and body of the 3rd coach, No. 1124, were on the Down Fast platform alongside the leading brake third, but the 4th, No. 34108, rode diagonally across the wreckage of the Perth train *to the right* and came to rest on the *Up Fast* platform. As has been mentioned, this was an all-steel coach of British Railways standard design; its underframe was only slightly distorted, but the greater part of its roof at the rear was torn away and left behind as it was forced upward against the footbridge girders, and the brake and luggage compartments occupying the rear half of the coach were wrecked; the front end was crumbled but not disintegrated and the partitions of the four passenger compartments remained in place. Coach No. 34108 appears in photograph 8, and photograph 10 shows the rear part of its roof which was left on the London side of the footbridge (some of the steel panelling had been cut away when the photographs were taken).

The destruction and damage to the 5th, 6th, 7th and 8th vehicles of the Liverpool train is shown by photographs 7, 8, 9, 10, 11 and 12. The steel body shell of the 5th coach, No. 24683, was demolished and its twisted underframe lay on the pile of bogies close to the footbridge, but the next two, Nos. 34287 (6th) and 27266 (7th) were carried beyond it on a straight course and mounted the engine of the Perth train and the other wreckage on the alignment of the Down Fast line. No. 34287, like No. 34108, was an all-steel coach of the new standard design, and it suffered a good deal less than the others; its underframe kept its shape well, as did the body shell, and all the compartments could be identified, although there was a good deal of internal damage. The body sides of No. 27266 behind it were torn from the underframe and it lay directly above the buried engine of the Perth train, with its roof about 30 ft. above the level of the rails.

The next coach was the kitchen car, No. 30049, marshalled 8th in the train. It was wedged under the footbridge (see photograph 10) with its leading end resting on a heap of five or six bogies and other debris, but its trailing bogie was still on the rails. The front end of its body was driven in (photograph 12), but structural damage to the underframe was not very severe; all the gas was discharged as the reservoirs were broken, but it did not take fire. It is impossible to say which of the four or five coaches which struck the underside of the footbridge were responsible for the breakage and doubling back of the main girder on its country side. There was no serious structural damage to the undergear or bodywork of any of the seven vehicles behind the kitchen car; except for the leading bogie of the 9th coach, none of their wheels was derailed.

Apart from other considerations, the extent and general character of the wreckage suggested that the Perth train and the Down Liverpool train were each running between 50 and 60 m.p.h. at the time.

II. Description of Site and Signalling

9. With reference to Figs. 2 and 3, Harrow and Wealdstone station is 11½ miles from Euston on the main " West Coast " route to the North. The direction of the lines through the station is North West (Down) and South East (Up), but the general direction of the route is more nearly North and South, and for the sake of convenience North and South references are used in the following description.

10. Except for a short distance at the start, there are six passenger tracks over the 17½ miles from Euston to Watford Junction, and at Harrow and Wealdstone their order on the formation is from East to West, Up Slow, Down Slow, Up Fast, Down Fast, Up Electric and Down Electric. The six tracks continue northward to Harrow on the same formation as far as Bushey (16 miles from Euston) where the electric lines diverge to the west, rejoining the main route as they approach Watford Junction station. The electric lines terminate at Watford, whence the four tracks continue northward through Tring (32 miles) as far as Roade Junction (60 miles from Euston).

11. In the Up direction, as the express from Perth and the local train were running, the line falls generally for the whole of the way to Euston from the summit at Tring, with long stretches of 1 in 335 and 1 in 339. Fig. 3 shows the gradients in detail, also the location of the stations and signal boxes southward from Watford Tunnel (North End) box, where the Perth train was stopped by signals; the intermediate stations which serve the electric lines only are shown in italic lettering. The water troughs (on all four steam lines) between Bushey and Hatch End stations will also be noted. Curvature generally is easy, and high speeds can be maintained by Up express trains; at present there is a general limit of 75 m.p.h. on this section.

12. Manual block working is in force on the main lines with semaphore stop signals and for the most part with colour light distants. The electric lines are automatically signalled with colour lights and continuous track circuiting. The main line signal boxes concerned are, in order from North to South:—

	Distance from point of collision
Watford Tunnel (North End) (No station)	*8½ miles North
Watford Junction No. 2 (North end of station)	*6½ ,, ,,
Watford Junction No. 1 (South end of station)	*6 ,, ,,
Bushey (station)	*4½ ,, ,,
Hatch End (station)	*2 ,, ,,
Harrow No. 1 (station)	33 yards ,,
North Wembley (station)	*2¼ miles South

* To nearest ¼ mile.

13. Watford Tunnel (North End) box is so named from its situation just north of the two Watford double line tunnels which are just over one mile long; at the time of the accident there was a permanent

way relaying speed restriction of 15 m.p.h. through the tunnel on the Up Fast line. From the tunnel southward, the four tracks are straight through Watford Junction station; after that there is a high embankment and viaduct on a right handed curve, which continues past the Bushey Up semaphore distants. There is a straight length through Bushey station, where the electric lines join the main formation, followed by a long left handed curve in a deep cutting where the water troughs are located. This cutting runs out to bank at the end of the troughs, and there is again a short length of straight as the Hatch End Up colour light distants are approached. Another long left handed curve, of 234 chains radius, begins at Hatch End station and continues on low bank and in shallow cutting for a short distance beyond the Harrow No. 1 colour light distants. These are situated 23 yards north of a road overbridge close to Headstone Lane station, which serves the electric lines only (see Fig. 5). Thenceforward to Harrow and for some distance beyond the four main steam lines are straight.

14. Fig. 4 shows the signalling and track layout at Harrow, the most important feature of which is the pair of facing crossovers, Up Slow to Up Fast (Nos. 18 and 19) and Down Fast to Down Slow (Nos. 16 and 17); they are subject to a speed restriction of 20 m.p.h. when set for the crossing movement. The signalling is controlled from Harrow No. 1 box by a mechanical frame of 44 working levers, including detonator placers for all four of the main lines. The signalman faces the Fast lines as he stands at the frame, and in clear weather he has an extended view of all the lines northward; he also has a good view of the lines through the station.

15. The signalling follows conventional practice, and it will be noted that on the Up Fast line there is an Outer Home signal, (No. 44), 440 yards in rear of the Inner Home (No. 43) which gives immediate protection to the trailing junction. The Outer Home is provided so that trains on the Up Fast line can be accepted freely from Hatch End box in rear while the junction is occupied by a crossing movement from Up Slow to Up Fast, in accordance with Absolute Block Regulation 4 (a) para. 2—see Appendix B. This is the usual method of working at converging junctions with Outer Home signals, whether they are geographical junctions or junctions between two parallel lines on the same formation, as in this case.

16. All the stop signals at Harrow are semaphores, and the Up Fast Starter (No. 42) at the London end of the platform has an "intensified" electric light behind the spectacles, as its arm is not very conspicuous against the background of the road overbridge. The profiles of the upper quadrant Inner and Outer Homes are shown by Fig. 5, and it will be noted that they are sited immediately to the left of the Up Fast line. There is a fog post at the Outer Home, but it was not manned at the time of the accident (see later).

All the four Distant signals are colour lights. With few exceptions colour light Distants have been provided throughout the length of the West Coast route between London and Carlisle in fulfilment of the programme which was initiated by the London Midland and Scottish Railway before the war to improve the view of the distant signals on their high speed main lines. Apart from their intrinsic brilliance, colour light signals have the advantage that they can be sited quite close to the level of the driver's eye; they are thus much more conspicuous than oil-lit semaphores, particularly at night and in fog, and the usual fog signalling arrangements at distant signals are not considered necessary where they are installed (see paragraph 23 below and Appendix B).

17. The Harrow No. 1 Up Fast (No. 45) and Up Slow (No. 37) Distants are carried on a gantry spanning the four lines, as shown by Fig. 6. They are 1474 yards from the Up Fast Outer Home (No. 44) which is the full braking distance for a speed of 75 m.p.h. on the falling gradient of 1 in 339. The aspects are lit by a local secondary battery continuously trickle charged through a rectifier from the main signalling power supply, and they are controlled by local relays operated from the signal box lever contacts through overhead line wires.

Of the three aspects, the uppermost is the auxiliary Yellow, the middle one is the Green, and the lowest is the main Yellow. The auxiliary Yellow is lit automatically if the bulb of the main Yellow aspect should fail; in these circumstances the repeater over the signal lever in the box goes to its "No Light" position, midway between its "Yellow" and "Green" indications, and at the same time a loud buzzer sounds which can only be stopped by the signalman turning a switch. Once the signalman has had the "No Light" indication, and the buzzer has sounded, trains have to be stopped and warned by the signalman in rear that the Distant signal ahead has failed, unless the latter can see the auxiliary Yellow light. The Up Fast Outer Home (No. 44) is also repeated in the box.

18. The beam from the main Yellow aspect was focussed to a spread of 4° and anything wider than this would result in an unacceptable loss of light intensity. Where a colour light signal is approached on a curve, the alignment of a narrow beam is a matter of compromise. In this case the beam was aligned horizontally so that its central axis crossed the near side rail of the Up Fast line 50 yards on the approach side of the signal, which brought the edge of the beam (2° from the axis) to cross the near side rail about 600 yards from the signal. The eye of an approaching driver would thus enter the main beam at a range of 600 yards, and the light which he would see would steadily increase in intensity until he was 50 yards from the signal. As he approached the signal very closely, he would lose the full effect of the main beam, and to compensate for this special prisms known as a "hot strip" are embodied in the main signal lens, and direct a separate intense beam of light towards him.

19. The clearing of signals for conflicting movements is prevented by the mechanical locking in the usual way. The reversal of the crossover 18 and 19 from Up Slow to Up Fast locks the levers of the Up Fast Inner and Outer Homes, also the Down Slow Inner Home at the country end of the platform (No. 9) and the Down Slow Outer Home (No. 8). The Up Slow to Up Fast directing home signal (No. 38) cannot be cleared until both ends of the crossover are reversed and the facing end bolted, and the

crossover is locked in either position when the Up Fast Starting signal (No. 42) is cleared; the crossover is, however, free of the Advanced Starter (No. 41).

The Up Fast Distant (No. 45) cannot be cleared until the levers of all the four stop signals of the Up Fast line have been reversed and, reciprocally, the reversal of its lever back-locks the stop signal levers. Similarly, the Up Slow Distant (No. 37) is preceded in the interlocking by the levers of all the signals for *straight through running* on the Up Slow line. It is *not* possible to clear the Up Slow Distant with the crossover set from *Up Slow to Up Fast*.

20. As will be seen from Fig. 4, there is extensive local track circuiting at Harrow, with indication by an illuminated diagram in the box. The four "combined" block instruments are of the three-position needle type, and each of the four bells which are rung from Hatch End and North Wembley for the Fast and Slow lines has a different tone. In common with practically all the mechanical signal boxes on the West Coast route, the standard "Class C" interlocked block controls of the former London Midland and Scottish Railway are installed on all four lines. They are designed to prevent a train from entering an occupied section, as the result of a signalman's mistake, and comprise:—

(*a*) Release of the signal controlling entrance to a block section, *for one operation only*, by acceptance of a train by the signalman at the far end of the section.

(*b*) Prevention of such acceptance unless either the first Stop signal worked from the box concerned is at danger or the lever working it is in the normal position. (On the Up Fast line at Harrow the acceptance of a train from Hatch End proves that the lever of the Up Fast Outer Home is normal *and* that its arm is properly at danger.)

(*c*) Interlocking between successive Stop signals worked from the same box to ensure that none can be cleared for a train unless that next ahead of it has been restored to danger.

(*d*) Exhibition of the "Train on Line" indication on the block instrument, even if not already displayed, while a track circuit approaching the Home signal is occupied; also the maintenance of that indication after departure of the train, until action is taken by the signalman to alter it. (The track circuits concerned were Nos. 2783, 2787 and 2776 on the Up Fast, Up Slow and Down Fast lines respectively, and their occupation with the Outer Home signal at danger sounds an "annunciator" buzzer in the signal box.)

Signals are controlled by the track circuits ahead of them in the ordinary way. Thus, the Up Fast Inner Home, No. 43, was electrically locked at danger when the local train was standing in the platform on track circuit No. 2782, as well as by the mechanical interlocking with crossover 18 and 19 set from Up Slow to Up Fast.

The facing point levers Nos. 16 and 19 are locked normal and reversed by occupation of the track circuits (Nos. 4113 and 4114 respectively) ahead of the directing signals, and these track circuits also lock reversed the facing point bolt levers Nos. 15 and 20.

21. A summary of the distances at Harrow which are relevant to the primary collision between the Perth train and the local train is given below; the North and South references are to the actual point of collision at the country end of the Up Fast platform, and the lever numbers at Harrow No. 1 box are given in brackets:—

Up Fast and Up Slow Distants (Nos. 45 and 37)	2,102	yards	North
Headstone Lane overbridge	2,079	,,	,,
Up Fast Outer Home (No. 44)	628	,,	,,
Up Slow directing Homes (Nos. 36 and 38)	333	,,	,,
Up Fast Inner Home (No. 43)	188	,,	,,
Trailing points (No. 18) of crossover Up Slow to Up Fast	80	,,	,,
Harrow No. 1 signal box	30	,,	,,
Point of first collision		—	
Harrow station footbridge Front of engine of Perth train after collision	78	yards	South
Up Fast Starter (No. 42)	185	,,	,,
Up Fast Advanced Starter (No. 41)	694	,,	,,

22. In the Down direction from South to North, the following distances refer to the point where the leading engine of the Down Liverpool train struck the derailed engine of the Perth train under the footbridge:—

Down Fast Distant	1,571	yards	South
Down Fast Outer Home	351	,,	,,
Road overbridge at London end of platform	130	,,	,,
Point of second collision		—	
Front of leading engine of Liverpool train after collision	75	yards	North
Down Fast Inner Home at country end of platform	89	,,	,,

23. Before my Inquiry on 15th and 16th October, I viewed the signals between Watford and Harrow from an 8P class engine running on the Up Fast line, and on 3rd November I made two further runs.

As has been mentioned, these engines are driven from the left hand side of the footplate, and they are provided with a narrow glass windscreen, hinged vertically to the outside of the cab sheeting in front of the rearmost of the two side windows. The driver sitting on his seat can thus look ahead continuously with his head partly out of the side window under the protection of the windscreen. This type of screen

is fitted to a large number of engines on British Railways; it gives effective protection to the driver's face and eyes in all weathers, and it can be kept clean with an ordinary wiping cloth.

These test runs were carried out in clear weather. Particular attention was paid to the view of the Distant signals, and to the possibility of confusion with the succession of colour lights on the Up Electric line to the right.

The Bushey semaphore* Distants could be seen for a considerable distance across the curve from the right hand (fireman's) side of the footplate, but as is well recognised by drivers they are not very conspicuous against the rising ground behind them. Thereafter on account of the prevailing left hand curvature and straight, all the signals could be seen readily from the driver's side. The Hatch End Up Distants, approached on the straight, were good clear colour lights, arranged in the same way as the Harrow No. 1 Distants, and up to that point the beams of Up Electric line colour lights were so much out of alignment when seen from the Up Fast line that confusion was very unlikely.

The yellow light of the Harrow No. 1 Up Fast Distant first came into view at a range of 733 yards, and from about 600 yards the Up Electric colour lights HL4 and RHL2 at the approach to Headstone Lane station could be seen clearly at Green a little to the right of it (see Fig. 4). At this stage, it appeared to an ordinary observer that the yellow light of the Up Fast Distant might have been a repeater signal on the Up Electric line, but there was no doubt whatever on nearer approach that it was an Up Fast line Distant signal. When first seen, its light was dull as the engine was obviously outside the main beam on the curve, but the light improved rapidly as the signal was approached, and when the engine was stopped 80 yards from it, it was very good. At about that point, the green light of the Headstone Lane Up Electric Starter HL2 could be seen ahead and to the right, but its beam was out of alignment. The Up Slow Distant came into view to the left of the Up Fast Distant at a range of about 500 yards. Neither signal can be seen from Hatch End box.

Continuing forward on the straight, three green lights of the Harrow Up Electric line Home signals and repeaters came into view before the semaphore Up Fast Outer Home. This was first seen against a good sky background at a range of about 800 yards, and there was a similar view of the Inner Home, also against a sky background. From the driver's side the intensified light of the Up Fast Starter at the London end of the platform could not be seen until the engine was close to the *Inner* Home, but it could be seen from the fireman's side just before reaching the *Outer* Home.

Generally, the view of the Up Fast signals at Harrow was entirely satisfactory in clear weather. The colour light Distants were located, as is generally possible with such signals, fairly close to the level of the eye of a driver on the left hand side of the engine, and the focus of their lights was good, having regard to the curvature. The Inner and Outer Homes were as conspicuous as is possible with semaphores. A certain degree of care is necessary to avoid distraction by the Up Electric line signals at Headstone Lane, but no more than is required at many other places where a driver has to depend on his acquired skill and his knowledge of the road to locate his own signals from others which may be in his view.

On this point, the driver of the engine on one of my special runs told me that the Up Electric line signals might appear confusing on a man's first two or three trips, but that after that there was no real difficulty. Another driver said that he did not allow the Up Electric signals to confuse him as he knew exactly how the main line Distants were located, i.e. just above and to the left of the cab, and " he let the signals come up to him ".

24. At the time of the accident the true bearing of the sun was 111½°. Its position was thus facing towards Up trains at an angle of 17½° to the left of the straight stretch of track between Headstone Lane and Harrow. Its altitude above the horizon was 9°.

III. Absolute Block Regulations governing Acceptance

25. Relevant extracts from the Absolute Block Regulations in force in the London Midland Region are given in Appendix B. The following is a brief summary of their effect on the acceptance of Up trains at Harrow No. 1 box.—

(*a*) *In clear weather* the signalman is permitted to accept a train from Hatch End on the Up Fast line up to his Outer Home signal at danger, at the same time as a movement is signalled over the crossover from Up Slow to Up Fast just ahead of the Inner Home.

(*b*) *In fog* he is allowed the same freedom *provided that a fogsignalman is stationed at the Outer Home*, since the colour light distant is regarded as the equivalent under these conditions of a semaphore distant with a fogsignalman stationed at it. (Regulation 4 (i)).

(*c*) If, however, in fog there is no fogsignalman at the Outer Home, acceptance of a train on the Up Fast line from Hatch End requires that the line should be clear for at least 440 yards beyond the *Inner* Home, which presupposes that the crossover is set in its normal position for straight through running on the Up Fast and Slow lines.

The Regulations stipulate that fog working must be put into force when the " fog object " can no longer be seen from the signal box, or if the signalman is unable to see for more than 200 yards when no fog object is laid down in the local signal box instructions. In these circumstances it is customary for the signalman to select his own mark, and at Harrow No. 1 the Up Slow Home signals were generally used for this purpose; they are 303 yards from the centre of the box so that the 200 yard limit was interpreted liberally.

It was recorded in the Harrow No. 1 train register that fog working (under (*c*) above) had been put into force at 6.35 a.m. on the morning of the accident when these signals became obscured. It was also recorded

* Since converted to colour lights in accordance with the programme.

in the register that normal working (under (*a*) above) was resumed at 8.10 a.m., 9 minutes before the accident, when the signals were again in view. These times of " fog on " and " fog off " at Harrow were also recorded in the Control office fog book.

The visibility at Hatch End and at North Wembley was such that the signalmen there had not considered it necessary to introduce fog working since they had taken duty at 6.0 a.m. At Bushey, where the Up distants were semaphores, the fog was becoming thicker between 7.0 a.m. and 7.30 a.m., and " double block " working under Regulation 4 (*e*) was in force from approximately 7.15 a.m. until a fogman arrived at the Up distants about an hour later. This, however, had not resulted in any check to Up trains as they were not following each other closely.

IV. Summary of the Circumstances in which the Accident Occurred

26. In addition to the local train and the express from Perth which were involved in the first collision, consideration has to be given to the 10.20 p.m. express from Glasgow which had preceded the express from Perth on the same line for the whole of the way from Crewe; also to a freight train on the Down Slow which passed the local and the Perth trains as they were approaching Harrow.

27. The more important block signal times which were recorded for these four trains in the registers at Hatch End, Harrow No. 1 and North Wembley signal box are summarised in the table below. There did not appear to have been any significant variation between the three clocks, and the times are fairly consistent when it is considered that they are entered to the nearest half minute. There were no corrections or erasures in the registers:—

	Accepted from rear	TES received	Accepted in advance	Train departed or passed	TOS received
			UP FAST AND SLOW LINES		
Hatch End					
10.20 p.m. from Glasgow ...	7.56 F	8.4 F	7.56 F	8.8 F	8.10 F
7.31 a.m. from Tring	8.5 S	8.10 S	8.6 S	8.13 S	10.25 S
8.15 p.m. from Perth	8.8 F	8.13 F	8.10 F	8.16 F	10.4 F
Harrow No. 1					
10.20 p.m. from Glasgow ...	7.58 F	8.7 F	8.5 F	8.11 F	8.14 F
7.31 a.m. from Tring	8.7 S	8.14 S	8.14 F	8.17*F	—
8.15 p.m. from Perth	8.11 F	8.17 F	—	—	—
North Wembley					
10.20 p.m. from Glasgow ...	8.6 F	8.10 F	8.10 F	8.13 F	8.14 F
7.31 a.m. from Tring	8.13 F	—	—	—	—
			F Up Fast S Up Slow * Arrived		
			DOWN SLOW LINE		
			4.32 a.m. Freight train, Norwood–Northampton		
North Wembley	7.39	7.43	7.52	7.52	8.12
Harrow No. 1	7.53	7.53	8.5	8.10†	8.45
Hatch End	8.4	8.9	8.37	8.40	8.55

† Train Out of Section was returned to North Wembley at 8.11 a.m.

The block signal times given in the text below refer to the entries in the register at Harrow No. 1 box, the clock in which was checked after the accident and found correct.

28. The 10.20 p.m. express from Glasgow, like the express from Perth, was hauled by a large 4–6–2 type engine of the 8P class, but the load of 14 bogie vehicles including 12 sleeping cars was heavier; the engine and crew had worked through from Carlisle. Fog had persisted from Wigan onwards, and the train was 20 minutes late when it ran through Crewe without stopping at 4.18 a.m. The fog was practically continuous from Crewe to Willesden, though it varied in density, and the train was approximately 93 minutes late when it ran through Harrow at 8.11 a.m. with all signals clear. It had passed the local train at Apsley (see Fig. 3).

The Glasgow train was accepted by the signalman at Harrow No. 1 at 7.58 a.m. on receipt of the Is Line Clear signal, which had been sent forward from Bushey and from Hatch End as soon as it was received in accordance with the local instructions; these instructions also provide that Is Line Clear should be " held back " at Harrow No. 1 until the receipt of a special Train Approaching signal to notify that the train is passing Bushey. In consequence, the Glasgow train was not offered to and accepted by North Wembley until 8.5 a.m. Train Out of Section was returned to Hatch End at 8.11 a.m. as the train passed, and was received from North Wembley at 8.14 a.m.

29. The 7.31 a.m. local train from Tring is one of a series which are run on weekday mornings to Euston from the residential area in the Chilterns. It is booked to stop at all stations to Watford inclusive, and should leave Watford at 8.1 a.m. to arrive at Euston at 8.27 a.m. after an intermediate stop at Harrow and Wealdstone (8.10 a.m. to 8.12 a.m.). It is also booked in the working time table to run to Harrow No. 1 box on the Up Slow line and to continue thence on the Fast line to Euston so as to leave the Slow line clear for empty stock movements from Willesden.

Every endeavour is made to keep these "residential" services to time. Except in emergency, the signalmen are not expected to vary the routing laid down in the working time table, and the residential trains are given precedence over any night expresses from the North which may be running late. This is well known to all the local staff, and main line drivers generally recognise that if they arrive late in the London area at this time in the morning they may expect further delays.

30. The local train left Tring punctually, but it was slowed by the fog, and it left Watford at 8.6 a.m., 5 minutes late. It was accepted by Harrow No. 1 box from Hatch End at 8.7 a.m., and Train Entering Section was received at 8.14 a.m.; the crossover had been set from Up Slow to Up Fast, in accordance with the booked working, at approximately 8.11 a.m., after the Glasgow express and the freight train on the Down Slow had passed, and probably on receipt of Train Approaching for the local train as it was passing Bushey (the Train Approaching signal is not recorded). Line Clear for the local train on the Up Fast was received from North Wembley at 8.14 a.m. directly the Glasgow express had cleared the section, so releasing (for one pull only) the lever of the Up Fast Advanced Starter, No. 41.

According to his statement, the signalman at Harrow No. 1 had waited to clear the signals for the local train (he had to commence with the Up Slow to Fast Home and work forward—see para. 20 (*c*) above) until the engine struck the Up Slow berth track circuit, No. 2787, at approximately 8.16 a.m., although he was not required by the Regulations to act in this way for a *booked* diversion. In the prevailing visibility the Up Slow to Fast Home was clear when the driver first saw it, but he had already reduced speed for the anticipated crossing movement on passing the Distant at caution. The train stopped for its station duties in the Up Fast platform at approximately 8.17 a.m., 7 minutes late. It had been standing there for at least one minute and probably rather more, with the two signals ahead clear for it to proceed on its journey, when it was struck by the Perth express.

31. The Perth express arrived at Crewe at 4.2 a.m., 13 minutes late; 16 minutes were allowed there for station work and for changing the engines, but the fog was very dense locally and further time was lost in attaching engine No. 46242. This was a London (Camden) engine which had worked to Crewe with a Down express, and it was in charge of a driver and fireman from Crewe North shed for its return journey. The train left Crewe at 4.37 a.m., 32 minutes late and 19 minutes after the 10.20 p.m. express from Glasgow which had passed it while it was standing in the station.

Though it was still losing time in the fog, the Perth train was gradually overtaking the Glasgow train on the journey South, and after several checks it was finally stopped for 2 minutes by signals at Watford Tunnel (North End) box when the Glasgow train was slowed by the 15 m.p.h. speed restriction through the tunnel in the section ahead; it restarted at approximately 8.3 a.m., 7 minutes after the Glasgow train had passed. The local train had passed the North End box at about 8.0 a.m., and had stopped at Watford station from 8.4 a.m. to 8.6 a.m.

The Perth train in its turn travelled slowly through the tunnel in compliance with the speed restriction, but with all signals clear through Watford, Bushey and Hatch End, speed was recovered rapidly on the falling gradient with the powerful engine and the moderate load; the recorded passing times suggested that it had covered the 6 miles from Watford to Harrow rather faster than the Glasgow train, though the actual averages of 48 m.p.h. and 40 m.p.h. respectively, which were calculated from signal box timings over a comparatively short distance, cannot be regarded as reliable. The Perth train was 7–8 minutes behind the Glasgow train when the first collision occurred between 8.18 and 8.19 a.m. and it was approximately 80 minutes late. It passed Hatch End 3 minutes after the local train at 8.17 a.m., at which time the latter had just arrived in the Up Fast platform at Harrow.

32. The Perth train was offered by Hatch End to Harrow No. 1 on the Up Fast at 8.11 a.m., directly Train Out of Section for the Glasgow train was received, and was accepted at once to the Outer Home at danger to allow the local train to cross to the Fast line ahead of it, in accordance with the authorised working at a converging junction in "clear" weather when there is an Outer Home—see paragraph 25 (*a*) above. It will be recollected (paragraph 25) that the signalman at Harrow No. 1 had resumed normal clear weather working one minute before at 8.10 a.m. when the Up Slow Home signals, 303 yards from the box, were no longer obscured.

Train Entering Section was received at Harrow No. 1 for the Perth train at 8.17 a.m., but instead of stopping at the Outer Home it ran past it and the Inner Home without reduction of speed, burst through and damaged the trailing points of the crossover, which was still locked reversed with the Up Fast Starting signal clear, and collided with the stationary local train. As has been stated, the driver and fireman were killed, but there was evidence that an emergency application of the vacuum brake was made a few seconds before the collision and before the explosion of the detonators which the signalman had placed on the Up Fast line when he saw that the Perth train was not stopping.

The 8.0 a.m. Down Liverpool express had started from Euston 5 minutes late owing to a minor vacuum defect which was quickly rectified, and with plenty of engine power it was regaining the lost time. It approached Harrow with all signals clear at about 60 m.p.h. and although the signalman was quick to throw the Down Fast signals to danger when he saw that a collision was imminent on the Up Fast line, the train was already so close that a second collision was inevitable. The Obstruction Danger signal was sent promptly to Hatch End and to North Wembley (recorded as 8.18 a.m. in the Harrow No. 1 train register).

V. Evidence of the Signalmen

33. The statements of the following signalmen are relevant:—

Up direction	J. Ashcroft	Bushey
	A. G. Horsfall	Hatch End
	A. G. Armitage	Harrow No. 1
↓	D. Pullen	North Wembley

All had booked on duty at 6.0 a.m. and from then until 8.18 a.m. 6 trains had been signalled at Harrow on the Up Fast, 5 on the Up Slow, 7 on the Down Fast and 6 on the Down Slow, or 24 in all, including the three trains concerned in the accident.

34. Signalman Ashcroft, who had worked at Bushey regularly for four years, said that his fog object 250 yards away was visible when he came on duty. It became obscured at about 7.15 a.m. and he sent Lengthman H. J. Richards, to his regular fog post at the semaphore Up distant signals when the latter reported to the box at about 7.45 a.m. According to the train register, the Glasgow and Perth trains passed the box on the Up Fast line at 8.5 a.m. and 8.14 a.m. respectively, and the 7.31 a.m. local train passed on the Up Slow at 8.11 a.m. Ashcroft said that all his signals were clear for these three trains and that the Perth train was travelling at about 60 m.p.h., considerably faster than the Glasgow train; he also thought that the speed of the local train was nearer to 60 m.p.h. than 50 m.p.h.

Ashcroft saw none of the enginemen as the trains passed, but Lengthman Richards, who had just reached his post at the Distant signals, and had not unrolled his flags when the Perth train passed him at about 8.13 a.m., recollected distinctly that a cloth was waved from the left hand side of the footplate in acknowledgment of his own wave of a hand to indicate that the Up Fast Distant was clear. Richards was quite sure that he was speaking of the Perth train as no more trains had passed on the Up Fast line, and he said that it was travelling at about 60 m.p.h. or at " ordinary express speed ", and faster than the local train which had passed him while he was on his way to his post. He added that the visibility was varying all the time from about 100 yards to 200 yards as the fog drifted.

35. Signalman Horsfall, who has worked regularly for the past 18 years at Hatch End, said that the weather was foggy, with visibility round about 300 yards, but he did not think that it was bad enough to delay the residential services seriously. He was entirely satisfied that there was no cause for him to adopt " fog block " working that morning, and he said that the visibility had improved considerably at 8.0 a.m. when he could see 500 yards or more. He added that the fog would thicken with steam and smoke as a train passed and then clear again.

He received acceptance for the local and the Perth trains at 8.6 a.m. on the Up Slow and at 8.10 a.m. on the Up Fast respectively (his clock was slightly slow compared with the clock at Harrow No. 1). He cleared all his signals for both trains in good time, and they passed unchecked at 8.13 and 8.16 a.m. The two trains were thus about 3 minutes apart, as at Bushey, and on being asked where he thought the local train would have been when the Perth train passed, Horsfall replied " I imagine by the time the Perth express was passing my box the Tring train was either crossing over the junction (at Harrow) or had arrived in the platform on the Up Fast ". He recorded 8.19 a.m. as the time at which he received the Obstruction Danger signal from Harrow No. 1.

The 10.20 p.m. Glasgow train had also passed under clear signals at 8.8 a.m., and he had received Train Out of Section in two minutes, which he said was the usual time for an express train to clear the two-mile section. He thought that this train had passed him at about 60 m.p.h., and he was definitely of the opinion that the speed was not too high under the prevailing weather conditions. He estimated that the Perth train had passed at about 55 m.p.h., and that the local train was travelling at much the same speed on the Up Slow. He " seemed to remember " having seen the face of the driver of the Perth train " through the spectacle ".

With regard to the freight train on the Down Slow, Horsfall said that he had to hold it at his Outer Home signal as the section ahead to Bushey was occupied; he received Train Entering Section for it from Harrow No. 1 at 8.9 a.m., and it arrived at the Outer Home at 8.18 a.m., about two minutes after the Perth train had gone by on the Up Fast. The two trains had therefore passed each other somewhere in the section.

In concluding his evidence, Horsfall said that he had no conversation on the telephone with Signalman Armitage either before or after the accident. From previous experience he regarded Armitage " as a very good man to work to ", and he had found him very prompt in answering bell signals.

36. A. G. Armitage, who was on duty at Harrow No. 1 box, is a District Relief Signalman. In order to avoid any misconception, I should mention that only men who are considered suitable are selected for the grade of Relief Signalman; they have to be passed as competent to take charge of several signal boxes in their area, after a stringent examination in each of them, so as to be able to relieve any of the regular men who may be absent for one reason or another.

Armitage, who is 34 years of age, joined the London Midland and Scottish Railway in 1938 and was working as a signalman when he enlisted voluntarily in the Army soon after the outbreak of war. After service in Military Transportation units at home and abroad, he returned to the railway in 1947, and was appointed signalman at Berkhamsted (Bourne End) at the end of that year. After a period of training in other boxes he was appointed District Relief Signalman Class 1 in the Watford area in February 1950, and was passed as competent to work Harrow No. 1 box in August 1951.

He had taken charge of Harrow No. 1 for a few days in September 1951 and again in March 1952, and had been relieving there from 30th September 1952 onwards. The accident occurred on Wednesday 8th October, and during that week he was on the 6.0 a.m. to the 2.0 p.m. turn, but he had been excused

from morning duty on the Tuesday for domestic reasons, and had been learning the working of Watford No. 1 box from 2.0 p.m. to 10.0 p.m. on that day instead. He had thus had a short night's rest before taking duty at 6.0 a.m. on the Wednesday, but he assured me that he was perfectly fresh for his work.

37. Armitage said that the weather was misty when he came on duty but he was satisfied that there was no need to introduce fog working at that time. The fog became thicker a little later, and as there was no fogsignalman at the Up Fast Outer Home he began fog working at 6.35 a.m. when the Up Slow Home signals became obscured, and there was an entry in the train register to this effect. He explained that it would have been useless to send for the fogmen at that time as they would have already left their homes to report for work at 7.30 a.m.; he said, however, that he had asked the local ganger for a fogman when the latter came to the box at about 7.40 a.m. and that he was given to understand that none were available.

He stated that he had been keeping a watch on the Up Slow Home signals and he reverted to normal block working at 8.10 a.m. when he could see for some distance beyond them, and this also was recorded in the register; he had, of course, no means of estimating the visibility at the Up Distant signals. (The fog block working before 8.10 a.m. had not delayed his acceptance of the 10.20 p.m. express from Glasgow or of the local train at 7.58 a.m. (Up Fast) and 8.7 a.m. (Up Slow) respectively, as the crossover was then set for straight through running on both lines, and they were both clear for the necessary distance ahead.) I verified from the Control office fog book that Armitage had telephoned to the Control at 6.35 a.m. to report " fog on " at Harrow, and at 8.10 a.m. to report " fog off ", as required by the Instructions.

He went on to say that he could see for practically the whole length of the Up Fast platform when he received Train Entering Section for the Glasgow express at 8.7 a.m. He noticed that there was a bigger crowd of passengers than usual on the platform waiting for the local train, and that some were standing close to the edge, so he telephoned to the station staff to warn them to stand clear. He said, however, that when the Glasgow train passed through at 8.11 a.m. it was not travelling as fast as he had expected.

38. On being asked when he reversed the crossover, Armitage replied that he could not remember exactly, but he said that it was probably when he received the Train Approaching signal for the local train at about 8.11 a.m., and immediately behind the Glasgow express. He had also given Train Out of Section to North Wembley at 8.11 a.m. for the freight train on the Down Slow (he could not, of course, reverse the crossover until it has passed). He accepted the Perth express at about the same time up to his Up Fast Outer Home at danger, as he was entitled in normal working (8.11 a.m. was recorded in the register for this acceptance).

He received Train Entering Section for the local train at 8.14 a.m. and he said that he got this train accepted by North Wembley at about the same time, directly he received Train Out of Section for the Glasgow express, but he waited to clear the signals for it until the engine had occupied the track circuit in the rear of the Up Slow Home; he then cleared the Home signal from Slow to Fast and the Up Fast Starter; also the Advanced Starter which had been released (for one pull only) by the acceptance from North Wembley. Armitage said that the local train arrived on the berth track circuit at 8.16 a.m. and that he saw the front of the engine well before it reached the Home signals. He replaced the Home signal to danger directly the train had passed through the crossover, and he said that it arrived at the platform at 8.17 a.m., just as he received Train Entering Section for the Perth express.

39. A minute or so later he was astonished to hear the sound of the Perth express approaching at speed, and he said that when he first saw it it was " coming out of the mist and passing my Outer Home signal on the Up Fast " (this signal is nearly 600 yards from the box). It was making no attempt to stop, so he immediately put the detonators on the Up Fast line by lever No. 40 (they were found exploded) and then threw the Down Fast signals to danger against the Liverpool express, for which he had received Train Entering Section from North Wembley at 8.17 a.m.; directly he did so the annunciator buzzer in the box sounded, indicating that the Liverpool express was already on track circuit No. 2776. He could not, however, remember having heard the buzzer as the Perth express approached the Outer Home signal at danger though it was afterwards found in working order. He was of the opinion that the Perth express was under steam and that its speed was " far in excess " of that of the Glasgow express, and he was unaware of any brake application; he saw nothing of the enginemen as the train passed the box. He said that the two collisions occurred within a matter of seconds and that he could barely distinguish one impact from the other. He recorded 8.18 a.m. as the time at which he sent the Obstruction Danger signal.

40. Armitage was questioned closely on whether he might have decided in the first place to let the Perth train run through unchecked on the Up Fast line and cleared his signals accordingly on receiving the acceptance from North Wembley at 8.14 a.m. (the bell signal for Is Line Clear on the Up Fast line to North Wembley is the same for all passenger trains which do not stop at Willesden)—and whether he might have then changed his mind as to the order of precedence of the two trains, restored his Fast line signals and reversed the crossover for the local train. He was also asked whether he had intended in the first place to send the local train through on the Up Slow and not to cross it over.

He was, however, unshaken in his statements that he had at no time had any intention to vary the booked routing for the local train and that he knew well that the local trains had precedence over late running expresses at that time in the morning. Armitage also explained that if he had cleared the Fast line signals for the Perth train and then changed his mind he would have had to replace his Fast line signals and reverse the crossover. With the interlocked block controls and sequential locking (paragraph 20) he would have had to ask North Wembley to cancel the acceptance and give him another before he could have cleared the signals for the local train. There was no reason to suppose that any such cancellation had taken place.

41. Signalman Pullen, who had worked at North Wembley for 5 years, stated that his " fog points " had been visible ever since he had taken duty at 6.0 a.m., and that there had been no necessity to work fog block. According to his register, he had given Train Out of Section to Harrow No. 1 for the Glasgow express on the Up Fast at 8.13 a.m., and he said that he had been offered another train at once and that he had accepted it. He had understood afterwards that this was the local train, but he said that he did not know it at the time as the 4–4–4 Is Line Clear bell code signified only that the train did not stop at Willesden.

Pullen said that this was the only train which had been offered to him on the Up Fast after the Glasgow train. He could not recollect any cancellation of an acceptance about this time, and there was no record of any such cancellation in his register, in which his entries were neat and orderly, with no alterations or erasures. Pullen also said that he had no conversations with Armitage on the telephone during the morning, and that he had had no difficulty with him in the exchange of block signals. He recorded that he had received the Obstruction Danger signal at 8.20 a.m.

VI. Evidence of the Trainmen

42. The driver and fireman of the 10.20 p.m. express from Glasgow were F. B. Halliburton and J. Parkinson, both of Carlisle (Upperby) shed. Halliburton, who has long experience of the main line to Euston, said that time was kept in clear weather as far as Wigan but that after that the fog was practically continuous to Willesden where the sun had come out. He described the run as one of the worst he had experienced for some time, with visibility restricted to about 50 yards for most of the way. He said, however, that he had had no real difficulty in observing the signals, semaphores as well as colour lights, though he had been compelled to reduce the speed from time to time from the general level of 50–60 m.p.h. at which he was travelling. He added that his last signal check was to Bletchley (36 miles from Harrow) after which he had a clear run to Euston except for the speed restriction through Watford tunnel. He recollected having passed the local train at Apsley.

He opened the regulator again after the tunnel restriction and said that he was " coasting with a breath of steam " as he approached Harrow. He had a clear view of the Harrow No. 1 Up Fast Distant at Green at a range of about 50 yards, and he said that he could not possibly have missed it; when asked whether he first saw the signal at a couple of engine lengths' distance he replied that it was a little more than that. He thought he was probably travelling at 55-60 m.p.h. at the time, and was entirely confident that the speed was not excessive under the prevailing conditions.

Fireman Parkinson generally confirmed Halliburton's account of the journey, and he did not think that the visibility was much more than 75 yards at any place, except possibly at Watford. He had been " catching " as many signals as he could during the journey and he observed the Bushey semaphore distant at Clear from his (right hand) side of the footplate. He did not see either the Hatch End or Harrow No. 1 colour light distants (they are well placed for long and short range view by the driver from the left hand side) but he recollected that Halliburton had conveyed to him by lifting his hand that he had seen the latter. Parkinson said that he had taken water at the Bushey troughs and that the driver " had put on a bit of speed " for the purpose.

43. The driver of the local train was A. W. Payne of Watford shed, who is 53 years of age and has a thorough knowledge of the Fast, Slow and Electric lines in the outer suburban area, though he is not employed on long distance express work. He had taken tank engine No. 2389 light to Tring, chimney first, and had returned with the 7.31 a.m. train; as he was running bunker first on the inward journey, he was driving from the right hand side of the footplate, but with no boiler in front of him this hardly affected his view of the signals.

Payne described the fog generally as " patchy " and said that it was bad at Tring and rather clearer through Watford and approaching Bushey, becoming thicker again at Carpender's Park and Headstone Lane. He had found the Up Slow distant against him at Watford Tunnel (North End) but had not been stopped, and after that all signals were clear until he reached the Harrow No. 1 Up Slow Distant which was at caution as he expected; he said that this distant was always " on " for the 7.31 a.m. train as it was booked to cross to the Up Fast line at Harrow.

He said that he was travelling at 45–50 m.p.h. at the time, and that he saw the signal at caution at a range of about 50 yards without any difficulty at all, but he had not noticed the indication of the Up Fast Distant alongside it. He reduced the speed accordingly and continued to look out for the Up Slow Home signals, and he mentioned that he was accustomed to use the Up Fast Outer Home as a location mark (this signal is 295 yards from the Up Slow Homes); he described the conditions at this point as hazy rather than foggy, with the sun breaking through, and a good deal clearer than at the Distant signal. He said that the Up Slow to Fast Home was " off " when it came into his view at a range of 150–200 yards; he added, however, that it was difficult to judge the distance of an object with any accuracy when running towards it. He said that he had a good view of the signal, and he ran forward through the crossover into the platform, stopping with his engine just in rear of the Starting signal. He saw the intensified green light of this signal as he ran into the platform, but he did not notice the indication of the Advance Starter 509 yards ahead.

After the train had stopped, Payne released the brakes, and he said that the fireman continued to look back along the platform (on the left hand side) for the guard's hand signal to start. In Payne's estimate the train had been standing for about two minutes when the first collision occurred, which he thought was rather longer than usual, and he referred to the heavy load of passengers. He went on to say that the train was driven forward for about an engine length by the collision and that he suffered nothing worse than bruises. He thought that the two engines of the Liverpool train had passed him at about the same moment as he felt the shock.

The fireman of the local train was A. R. Hine, who is 20 years of age. His evidence generally was vague, but he recollected that the sun was trying to break through the fog somewhere about Hatch End. He saw the Harrow No. 1 Up Slow Distant at caution at a range of " 20–30 yards " and he said that Driver Payne had crossed over to the left hand side of the engine to observe it. He had also noted that the Up Slow to Fast Home was " off ", and he saw a large crowd of passengers on the platform as the train ran in. He thought that the train had been standing " for a long time ", perhaps 1½ minutes, when the first collision occurred, and he remarked that people seemed to be getting in and out.

The guard, W. H. Merritt, was travelling in the brake compartment at the rear of the last coach but two (7th). He did not see the Harrow No. 1 Distant, but he said that the train was almost stopped at the Up Slow Homes; he lowered his window and looked out as the train was slowing down, and said that he could see the engine (140 yards from him) as it passed the signals, with the Up Slow to Fast arm " off ". When the train stopped at the platform, he walked forward a little way, and he said that he gave permission for some passengers to get into the brake compartment as the train was crowded. He then went back to shut the doors in the two coaches behind his van, and was doing so when he heard the Perth train approaching at speed. Directly he saw it he took cover under the coping of the platform on the Down Slow side, and waited there until the noise of the second collision had died away. After that he went to the signal box and was assured by Armitage that all lines were protected.

44. The enginemen of the 8.15 p.m. express from Perth who lost their lives were Driver R. S. Jones and Fireman C. Turnock, both of Crewe North shed, and I refer to them later in Section VII. The running of the train was well described by the guard, J. Kent, who is stationed at Carlisle; he is 61 years of age and has 10 years' experience of main line express working on this route.

After working from Carlisle with another train, Kent had joined the Perth train at Crewe, where he had given Driver Jones the usual information about the load, and had passed instructions to him to make special stops at Nuneaton and Rugby, which were part of the train service alterations on account of the resignalling work at Euston. He said that Jones had seemed in good health when he had spoken to him and had remarked on the fog and difficulty he had had in backing on to the train; he had not, however, displayed the least anxiety about the journey and had told Kent that he would do his best in the circumstances.

Kent went on to say that after leaving Crewe at 4.37 a.m., 32 minutes late, the train continued to lose time and he thought that this was due in the main to the driver " finding his signals " in the fog. His journal recorded signal checks at Baddesley and at Atherstone (between Stafford and Nuneaton) also at Watford Tunnel (North End), and he said that the brake had operated normally on all these occasions, as well as at the special stops at Nuneaton and Rugby. According to his recollection the train was nearly stopped at Watford Tunnel North End (it was actually stopped for 2 minutes) and he said that the subsequent speed restriction through the tunnel had been strictly observed. He lowered his window and looked out as the train was " getting up to normal speed again " through Watford station, where the weather was a good deal clearer; he could see forward as far as one of the leading vans (180–200 yards) and he noted that all the signals through Watford were " off ".

Soon after that he began to tie up his invoices into bundles to be thrown out into the net at Camden Goods Yard, and he mentioned that he had a good deal more invoices and letters than usual owing to the train alterations. The train was " just getting into its swing again " when the collision occurred and he thought it might have been travelling at 50–55 m.p.h. The first indication to him that something was wrong was a severe application of the brake, and he had noted that his van vacuum gauge had gone to zero almost instantaneously. This brake application was followed at an interval which he estimated as about 5 seconds by three violent forward lurches and then by an equally violent rebound. His impression was that the driver " had spotted something just too late ".

Kent was not injured, and got down with a red flag and detonators with the intention of protecting the Up Fast line, but he was quite close to the signal box and went there first of all. The signalman, who appeared to " have had a shaking ", had told him that all lines had been protected, so he went round to the off side to make sure of the Down Fast line, and was surprised to see that the Liverpool train had already run into the wreckage.

He said that when he got down he could see forward for the length of the four sleeping cars (about 100 yards), but he thought it quite likely that the visibility in this direction might have been affected by steam from his own engine which was embedded in the wreckage. When asked how far he could see backward, he replied that it was " a lot more ". Kent said that he had looked sideways through the window of his van once or twice between Watford and Harrow and he described the visibility generally as " not dense but patchy ". He did not think it was bad enough to have the fogmen out just there, though he could recollect having heard their detonators between Crewe and Rugby.

Travelling Ticket Collector J. E. Smith was in the van with Guard Kent, and he confirmed that the brake went on hard just before the collision, as also did Sleeping Car Attendant H. V. West who suggested that the interval was about 2 seconds. West and the other two attendants stated that none of the sleeping car passengers was injured.

45. As has been mentioned, the 4.32 a.m. Down freight train from Norwood to Northampton was travelling on the Down Slow line between Harrow and Hatch End during the few minutes before the accident. The load was 58 empty four-wheeled wagons, and the train was hauled by a heavy eight-coupled engine, driven from the left hand side.

The driver was R. C. Brown, of Willesden shed. According to his statement, the train was checked at the Harrow No. 1 Down Slow Outer Home (No. 10) and stopped for about 3 minutes at the Inner Home

(No. 9) at the country end of the platform. He thought that he had restarted at about 8.9 a.m., and it will be recollected from Signalman Horsfall's evidence (para. 35) that the train had been stopped at the Hatch End Outer Home at approximately 8.18 a.m. Brown looked back along the train as usual after he had started and he said that he could see about 30 wagon lengths at the most (approximately 200 yards), and on being asked whether he would have expected the fogmen to have been out, he replied that it was hard to say, as the fog was drifting.

He recollected having passed the Perth train somewhere north of Headstone Lane station, and that the fog was noticeably thicker there, as he had often found it where there were open fields. He had seen the Hatch End Down Slow colour light Distant at Yellow at a range of about 50 yards or two engine lengths (this signal is approximately 345 yards *south* of the Harrow No. 1 Up Distants), and he added that the visibility was about the same when he passed the Perth train. His engine was of course steaming on the rising gradient, and he remembered that the steam from the chimney was blowing from left to right (away from the Up Fast line and across the Up Slow). Fireman G. T. Lane also remembered having passed the Perth train north of the bridge at Headstone Lane. He said that it was travelling " at the normal speed for that type of train " and he confirmed Driver Brown's estimate of the visibility at that point. Neither had noticed the Harrow No. 1 Up Distants.

The guard of this freight train was T. Starmer, who has 25 years' railway service and has been a goods guard for 14 years. According to his statement, the train left Willesden at 7.25 a.m. and was stopped by signal for 2 or 3 minutes in the Down Slow platform at Harrow. As it started again at approximately 8.11 a.m., Starmer was on the verandah at the rear of his van, and when it was about 20 yards beyond the trailing points No. 17 in the Down Slow line, he noticed that the Up Slow to Up Fast crossover had been reversed; he did not, however, see the points move behind his train. He also noticed that the Up Fast Inner and Outer Homes were " on " when he passed them.

He recollected that the local train had passed him on the Down Slow a little later; he did not actually see the train as he had then gone inside the van, but he judged from the sound that it was travelling quite slowly and that the brakes were being applied for the crossing movement. He said that after that he came out on to the verandah again and looked for the Up Slow Home signals, but they were then out of his view. On being asked why he had been interested in the Up Slow signals, he replied " I don't know. It was a matter of passing interest, force of habit. I knew the points were over, then I looked at the signals for the Up Main line. They were on ".

Starmer also remembered having seen the Perth train go by on the Up Fast after he had heard the local train on the Up Slow. He stated at the Regional Inquiry that it passed him just before his van got to the Up Distants, and he noted that the Up Fast Distant was showing a yellow light; he did not, however, recollect having seen the Up Slow Distant, and he said he was looking for the Fast line signal because he had seen the express go by. At my Inquiry he was not quite so definite, and said that the Perth train had passed him " round about Headstone Lane ", and he added that he had come out on to the verandah when he heard the train go by. He said that it was travelling " at the normal running speed for an express train "; he was sure that it was not braking, but it had not occurred to him that the train would fail to stop at the Outer Home, as it had ample braking distance. He was also " pretty certain " that he had seen the Up Fast Distant at caution but he did not see the Up Slow Distant; he explained that he was going under the bridge at the time and there was a good deal of smoke and steam hanging about from his own train, and he also said that the Up Slow Distant was at a different " angle " from his van.

With regard to the visibility, Starmer said that the weather was fairly clear when he left Willesden at 7.25 a.m., but it became " misty " as he travelled north. He could see forward about half the length of the train (about 200 yards) as he left Harrow, but not so far in the neighbourhood of Headstone Lane.

46. The driver of the leading engine of the Liverpool train was killed, but the fireman, G. Cowper, of Edge Hill (Liverpool) shed, had a remarkable escape; he was thrown clear of the engine in some way and he told me that when he came to he was lying on the upturned wheel splasher of the train engine. He said that he saw the Down Fast Distant " off " at Harrow, and he thought that the train was not travelling at " full speed " at the time of the collision, of which he remembered very little.

W. H. Darton, also of Edge Hill, was the driver of the train engine. He was looking ahead from the left hand side and he saw nothing of the obstruction ahead, but he was definitely of the opinion that the leading engine struck the engine of the Perth train as the impact was so heavy. He thought that his train was running at about 50 m.p.h. at the time having regained two minutes after the late start and he added " we could not help picking up time with the power we had ", although he was not working his engine hard.

He said that he had had no trouble whatever in seeing the signals and that the sun was coming through at Harrow, and he had remarked to the fireman that it was going to be a nice day. He saw the Harrow No. 1 Down Fast distant at Green and he had just seen the Outer Home " off " when the train entered the station and the collision occurred. He did not see any of the Down Fast signals go to danger. Darton was buried in coal as his engine overturned, but he got himself out fairly quickly and received medical attention to his badly torn hand after he had been assured by one of the station staff that the opposite line had been protected.

I interviewed Driver Darton and Fireman Cowper a month after the accident, but Darton's fireman, G. Dowler, was well enough to make a statement at the opening of my Inquiry on 15th October. He remembered very little of the actual collision, but he said that his mate was trying to get a bit of time back after the late start. He suggested that the speed of the train at the time was between 40 and 50 m.p.h., and that it had not reached 60 m.p.h. Guard A. Smith, however, thought that it was running at over 50 m.p.h.

and increasing its speed. Smith was travelling in the brake third marshalled 11th, and he described the shock as very violent. He had not seen any of the signals, but he had been looking sideways out of the van window as the train passed North Wembley, and he described the visibility as quite good.

VII. Evidence regarding Engine Crew of 8.18 p.m. Train from Perth, and Condition of Engine No. 46242

47. The driver and fireman were R. S. Jones and C. Turnock of Crewe North Motive Power Depot. Driver Jones was 43 years of age. He entered the railway service in 1927 as a cleaner, and was passed for firing duties in 1934. He was appointed Fireman in 1937, and was approved as competent to act as a driver when required in August 1946, after the usual verbal and practical examination, in which he gained 84 marks out of a possible 90; the minimum required for a " pass " is 65. He was appointed Driver in January 1948.

At the time of the accident he was in a spare or " block " link, which is maintained as a pool from which men may be drawn, often at short notice, to take the place of men who may be absent, or for working trains under the instructions of the Control, on any route of which they have confirmed their knowledge by their signatures on the route card. On any particular day each man in the link is given a " block time " which is fixed with due regard to his rest interval and he may be booked on duty two hours either side of this time. On the day in question, Driver Jones' " block time " was 3.0 a.m.

Since he had been passed for driving in 1946, Jones had familiarised himself with most of the routes radiating from Crewe, including the whole of the main line from Carlisle to London (Euston), and he had signed the route card to confirm his knowledge of the Crewe–Euston line on 31st March 1950. From that date until the end of September 1952 he had worked a total of 41 trips from Crewe to London, 29 of which were with express passenger trains. Of the remaining 12, 11 were with parcels, empty stock and fast fitted freight trains, the majority of which would have travelled on the Up Fast line in the London area, and one was with a light engine.

Included in the above were three trips with express passenger trains in July 1952, and three in August 1952. In September 1952, he had driven a light engine to London on the 2nd, and fast fitted freight trains on the 5th, 10th and 18th, and on 20th September, 18 days before the accident, he had worked to London with an express passenger train which left Crewe at 9.0 a.m.

48. Driver Jones had been off duty for the whole of the Saturday and Sunday before the accident. On the Monday morning he had worked an early trip on the Liverpool line, booking off duty at 11.40 a.m., and on the Tuesday he had been booked on at 4.25 a.m. to work to Morecambe, and he had booked off at 2.40 p.m. On Wednesday 8th October he was called at his house by the shedman at about 1.45 a.m. and had booked on duty at 2.45 a.m. At about that time he was told by Running Shift Foreman J. Hallmark that he was to work the Perth train forward from Crewe with Engine No. 46242 in place of the regular driver who was on leave, and return to Crewe with the 8.30 p.m. Postal train from Euston. The engine had been prepared by another crew, and Driver Jones had plenty of time to read his notices and " oil round " before leaving the shed at approximately 3.45 a.m. As has been mentioned, the engine movements and station working generally at Crewe were behindhand owing to the fog, and the Perth train did not leave on its journey south until 4.37 a.m., 32 minutes late.

From his experience of Driver Jones at the shed, Hallmark was entirely satisfied with his work and regarded him as a steady, even tempered man and a good driver, and he said that Jones had seemed perfectly normal when he had spoken to him that morning. Evidence about Driver Jones was also given by Firing Instructor W. S. Davies, who had known him practically all his service. He spoke of him as a " methodical young man " who showed a keen interest in his work and was in the habit of attending improvement classes in his spare time. So far as could be ascertained from enquiries which were made by the District Motive Power Superintendent, Mr. J. C. Foster, and by Firing Instructor Davies, Driver Jones had taken a short nap when he got home at about 3.0 p.m. on the Tuesday, and after spending some time in repainting the interior of his house, had gone to bed at about 7.45 p.m. As I have received a suggestion that he might have been suffering from the after effects of inhaling the fumes of some special kind of paint, I should mention that he had been using ordinary hard gloss enamel.

Mr. Foster, who has about 900 drivers under his charge, knew Driver Jones by sight and name, but he could not speak of his individual work, except to say that he had had no reason at any time to question his reliability. I was also told by Driver J. Hampton, who was a close contemporary of Driver Jones, and a personal friend, that the latter was a straightforward man who was very interested in his work, and that he paid more attention to his house and family than anything else in his off duty hours. Driver Hampton had spoken to him in the station just before he left with the Perth express and had found him his usual self.

Driver Jones' health was stated to be good at the medical examination when he passed as competent to drive in 1946 at the age of 37, and his sight at that time, including his colour vision, was normal in every respect. There was no record that he had been off duty for any sickness except for a week's absence with bronchitis in 1947. A general post-mortem examination disclosed nothing to suggest that he was not a perfectly healthy man and it was stated in Dr. Donald Teare's report that he was not suffering from the effects of diabetes, alcoholism or carbon monoxide poisoning at the time of the accident. There were, however, indications that he had taken a few breaths of carbon monoxide laden steam before he died from his head injuries. This might well have resulted from hot gases and steam blowing back through the fire hole door when some of the steam connections in the smokebox and the front tube plate were damaged by the collision, and from the discharge of hot water and steam from the broken water gauge drain cock (para. 5). As will be seen later, there was nothing to suggest that a blow back might have occurred before the collision.

49. Fireman C. Turnock was in the regular link from which an engine crew was provided for the Perth train on the 8th October, and he had booked on duty at about the same time as Driver Jones. He was 23 years of age and had joined the Motive Power Department as a bar boy in 1943; he became a cleaner in the following year, and was appointed fireman in 1945 at the age of 16. He had worked fairly regularly on London turns since he returned from his military service in 1949, and records showed that he had fired express passenger trains to London on 21 occasions in 1951, and on 13 occasions in 1952, including three trips in June, one in July and two in August. He had also fired an express passenger train to London on 3rd September, five weeks before the accident.

Mr. C. R. Campbell, the Divisional Motive Power Superintendent, knew Turnock as a very promising fireman, and he was well spoken of by Firing Instructor Davies, who had taken him out on express passenger work in 1949. Davies described him as " exceptionally good, and out to learn all he could and build himself up to be a good driver."

50. As has been stated, Engine No. 46242 was of the 8P class, with 4-6-2 wheel arrangement, and it was one of the most powerful express passenger engines in the country. It was stationed at Camden Motive Power Depot and was returning home from Crewe after working the 7.20 p.m. express from Euston on 7th October. It had run approximately 906,656 miles since it was built in May 1940, and approximately 27,300 miles since the last workshop repair in July 1952.

The engine was stopped at Camden on 28th and 29th September for the routine 3–5 weekly and " X " examination, details of which are given in Appendix C; none of the minor repairs were in any way unusual. Between this examination and the morning of 7th October, the engine had worked two return trips to Carlisle, three to Liverpool and one to Crewe, and during this time two water gauge glasses were renewed, and attention was given to minor steam leaks at the left hand injector steam valve and the carriage warming steam valve as the result of drivers' reports. As has been stated, both the water gauge glasses were found intact after the accident.

On the journey to Crewe on the evening of 7th October, the driver had reported that the engine was not steaming well, but later investigation showed that this had been due to unskilful firing; this driver had also reported a loose slide bar bolt, which was put right at Crewe before the engine left with the Perth train on the morning of 8th October. At the time of the accident the engine had run approximately 3,040 miles since the " X " examination on 28th and 29th September.

51. As soon as it was possible the engine was examined at Harrow by Foreman Fitter C. A. Marshall who is in charge of the repair work at Camden, and by Foreman Boilersmith E. J. Ambrose who is responsible for the boiler work there and at four other sheds in the district.

Except for the damage which had obviously been caused by the accident, Mr. Marshall found no trace of any defect on the footplate or elsewhere which could have distracted the attention of the enginemen, though he said that if there had been a blow back through the fire hole door it would not have necessarily left any trace of smoke or soot in the cab. He considered that the engine should have been in very good mechanical condition at a mileage of 27,300 since the last workshop repair.

Mr. Ambrose had confined his examination to the firebox, which he said was in first class order with no signs of leaking tubes or stays, and he had found the two fusible plugs intact. The back row of bricks was missing from the firebox arch, but this would not have affected the steaming to any material extent. No bricks had fallen into the fire, and Mr. Ambrose thought that the back row had probably been missing for several trips, as seems to have been confirmed by a driver's report on 30th September that the brick arch required examining. It was in fact examined at Carlisle, but no attention was considered necessary for the time being.

52. At my request, the engine was thoroughly examined at Crewe works after the accident, and no material defect was found apart from the very extensive damage—see Appendix D. It will be noted that the firebox was reported to be in sound condition, with only slight leakage in the tube plate at two large and two small tubes. All the tubes were in good condition with negligible wastage, as were the superheater elements, nor were there any signs of local wastage of the main steam pipes. The safety valves were tested under steam with satisfactory results, and the regulator was in order and operated smoothly. The water scoop gear of the tender was badly damaged, but it was clear that the scoop had been in the full " out " position when the collision occurred.

53. When the engine was recovered, the regulator was found fully closed (photograph 3). The reversing screw was in forward gear at 60 per cent. cut off, which is the normal coasting or " drifting " position, and the blower was open by one turn of the screw valve. Driver Jones' hand was on the vacuum brake valve handle in its fully applied position, hard over to the left.

All the evidence suggested that Driver Jones had made no attempt to stop until the very last moment. If the engine had then been under power it could only have been steaming lightly on the falling gradient at a short cut off and there would have been no time to screw the reversing gear forward into the coasting position in which it was found. The position of the engine controls, including the blower, therefore suggested that the train was already coasting as it approached Harrow, and I was informed by Mr. Foster and by the Head Office Locomotive Inspector, Mr. A. H. Sparkes, that unless time was being recovered it was quite usual for drivers of Up express trains to close the regulator after taking water at Bushey, and coast all the way to Euston except for a brief application of steam near Willesden. This was also confirmed by Driver Hampton, and by Driver Darton of the Liverpool train.

VIII. Evidence of Signal and Telecommunications Staff

54. As has been mentioned Mr. S. Williams, Signal and Telecommunications Engineer of the London Midland Region, was travelling in the local train. He told me that he went to the signal box almost immediately after the collision where he found Mr. Abraham, the Regional Motive Power Superintendent, speaking on the telephone. He noted that levers 15, 17, 18, 19 and 20 and no others except the Up Fast detonator placer lever No. 40 were over in the frame, and he verified by trying the catch handles, without moving any levers, that the levers of the Up Fast Inner Home, Outer Home and Distant signals were locked in their normal positions. He also noted that all four block instruments were at Train on Line. After that he told Telegraph Lineman C. Thorpe to go back on foot and check the aspect of the Up Fast Distant. Mr. Williams described the visibility when he got out of the train as " a half fog ", with visibility " about 200–300 yards and clearing ".

55. Thorpe's duty was to maintain the block telegraph apparatus and track circuits. He was in the small depot at Harrow when the accident occurred, and he met Mr. Williams in the signal box a few minutes afterwards. He said that at that time he could see the Up Slow bracket signals from the box and beyond them, and when he went back on Mr. Williams' instructions, he could see from the Up Fast Inner Home to the Outer Home (440 yards). When Thorpe arrived at the distant signals about half an hour after the accident, he noted that they were both at caution with the main yellow aspects alight; he added that the weather was then quite clear, with the sun shining. When he got back to the box he tested the Up Fast berth track circuit annunciator on Mr. Williams' instructions, and found it in working order.

56. Telegraph Inspector H. A. Fishenden arrived at Harrow at 9.45 a.m. from his headquarters at Watford. He went straight to the signal box and after noting the position of the levers he verified that the signal repeaters were all showing " on ". A little later he made a thorough test of the mechanical interlocking and found it correct, and between 11.0 a.m. and 12 noon he walked back to Headstone Lane and noted that the Distants were showing " two distinct yellows ". At about 1.0 p.m. he tested the electrical controls, including the track circuits, with satisfactory results, and at the same time he checked the working of the Up Fast Distant (No. 45) repeater and " No light " buzzer, with a man on the telephone at the signal location. He found that the repeater was responding correctly to the aspects shown by the signal and that it went to its " No light " position when the main yellow and auxiliary yellow bulbs were removed in turn—see para. 17.

57. In order to examine the possibility of a false clear aspect having been shown by the Up Fast distant signal as the Perth train approached it as the result of a cross or stray feed to the line wires or at the signal location, or from any other defect, I asked Mr. Williams on the first day of my Inquiry (15th October) to arrange for special tests. These were carried out on the same afternoon by Mr. D. Hewitt, the Area Assistant at Watford, with the assistance of Mr. N. P. Hennessey, Technical Assistant at Mr Williams' headquarters. Their report, Appendix E, was presented to me on the following day, when they explained the tests in detail, stating that the circuits at the signal box, the feed and return wires and the local circuits at the signal had all been included.

Both Mr. Hewitt and Mr. Hennessey are thoroughly experienced in tests of this kind and they expressed themselves as entirely satisfied with the insulation of the circuits throughout, expecially as the tests had been made under adverse conditions in damp weather, and that all the contacts and relays were working correctly. In their opinion and Mr. Williams', there was no possibility that the signal could have been showing a false clear aspect with its lever normal in the frame.

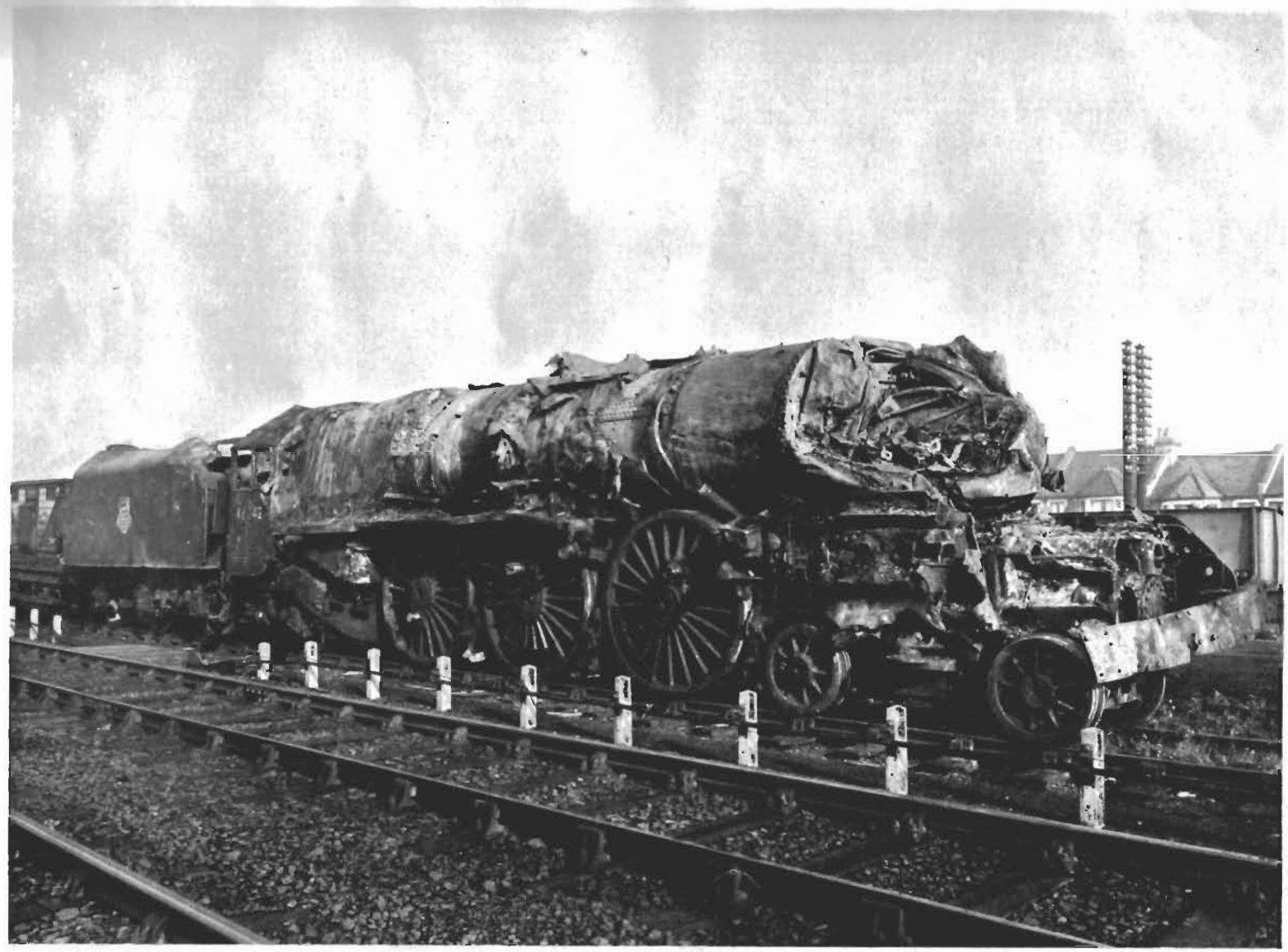
Neither of these officers, nor Mr. Williams, nor the Divisional Signal and Telecommunications Engineer, Mr. Davis, had known of any false clear aspect at colour light distant signals of this type since they have been introduced in 1936, except during installation work, and no such reports had been received at any time by the Operating and Motive Power Departments. Signalman Armitage also stated in his evidence that he had had no trouble with any of the Distant signal lights while he had been working at Harrow.

58. Signal Lineman S. W. Dell was travelling with his tools and materials in the leading brake compartment of the local train; he was on his way to Harrow to give the fortnightly routine attention to the points and signals. He stated that he was looking forward through his front window on the right hand side of the van, and that he had a clear view of the Harrow No. 1 Up Fast and Up Slow Distants. He saw their two yellow aspects distinctly, and said that he could not help noticing them, although they were obscured from his view by the engine until he was about 20 yards from them. He estimated that if he had been in " direct line " with the signals without any obstruction in front he could have seen them through the mist at about 200 yards, but when he was told that others had estimated the visibility there as 50–70 yards he observed that " it was very deceptive ".

He described the visibility generally as patchy, and said " it was quite clear as we approached Harrow. I should say we could see $\frac{1}{4}$ mile and the sun was breaking through ". Dell also gave evidence that the trailing end (No. 18) of the Up Slow to Up Fast crossover had been run through and damaged by the Perth train, as I confirmed by personal observation on the morning of the accident.

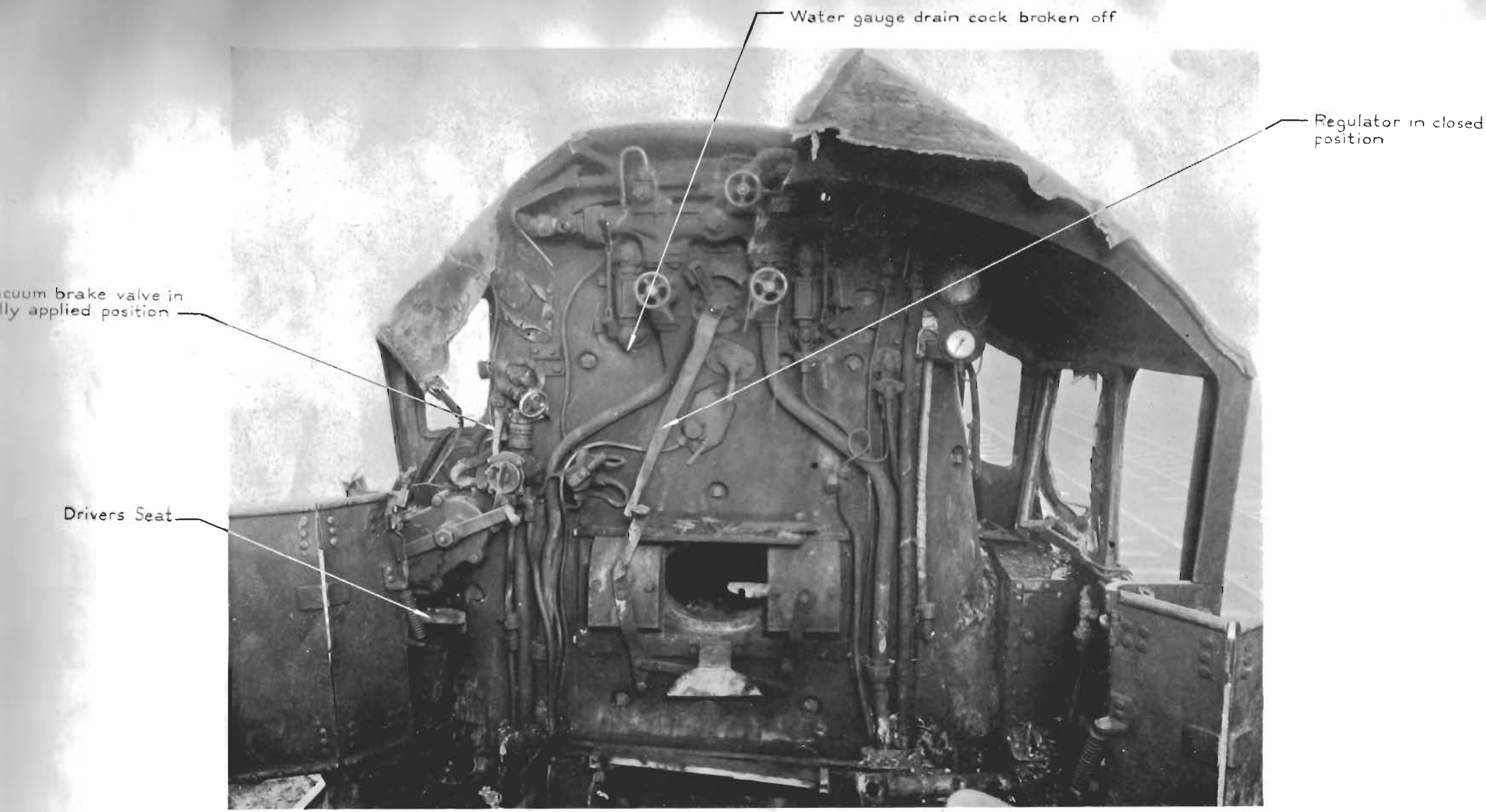
IX. Evidence of Harrow Station Staff and others

59. Mr. C. S. Rolinson, the stationmaster at Harrow and Wealdstone, had arrived for his day's duty at 8.0 a.m. He went to the Up Fast platform at about 8.10 a.m., as usual, to attend to the 7.31 a.m. local train and he thought that the visibility at that time was about 200 yards in each direction, with the sun just appearing above the mist. He did not, however, give any consideration to whether the signalman should have been working fog block, and he was not certain of the fog object, but he would have expected the signalman to have been working normally with 200 yards visibility.

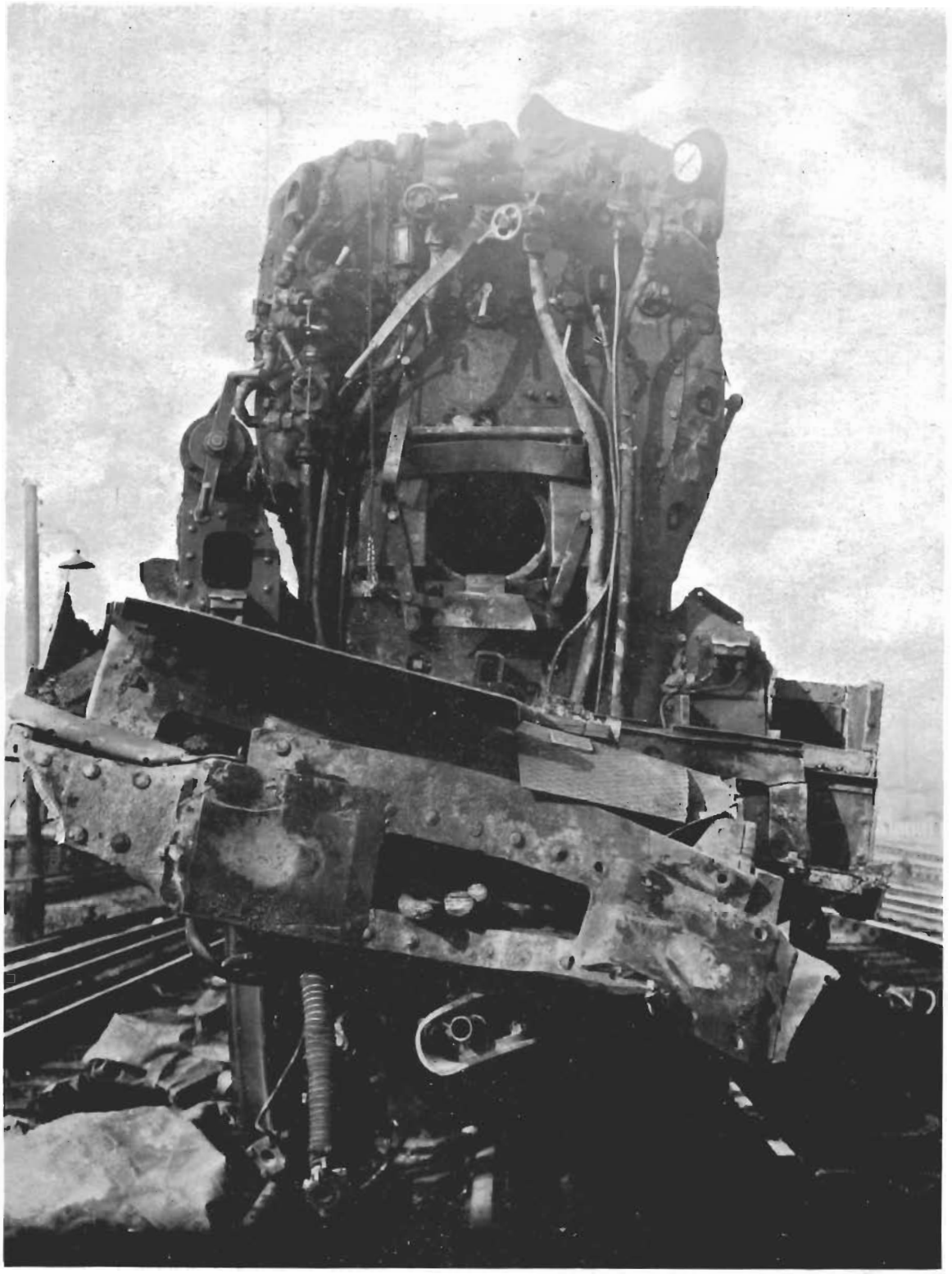


1. ENGINE NO. 46242. *Class* 8.*P.* 8.15 *p.m. Train from Perth* (*para.* 5)

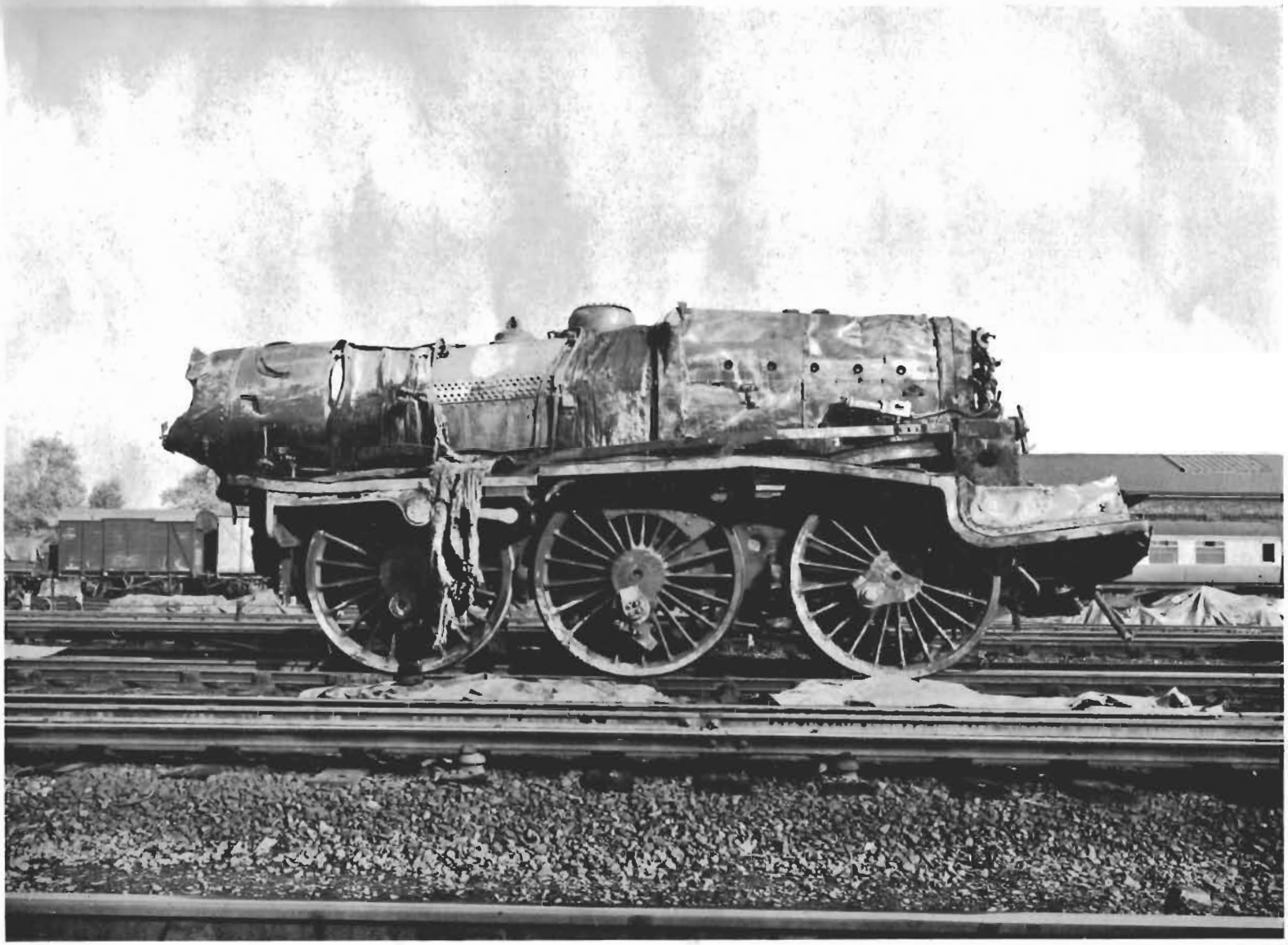
2. ENGINE NO. 46242. *Class* 8.*P.* 8.15 *p.m. Train from Perth* (*para.* 5)



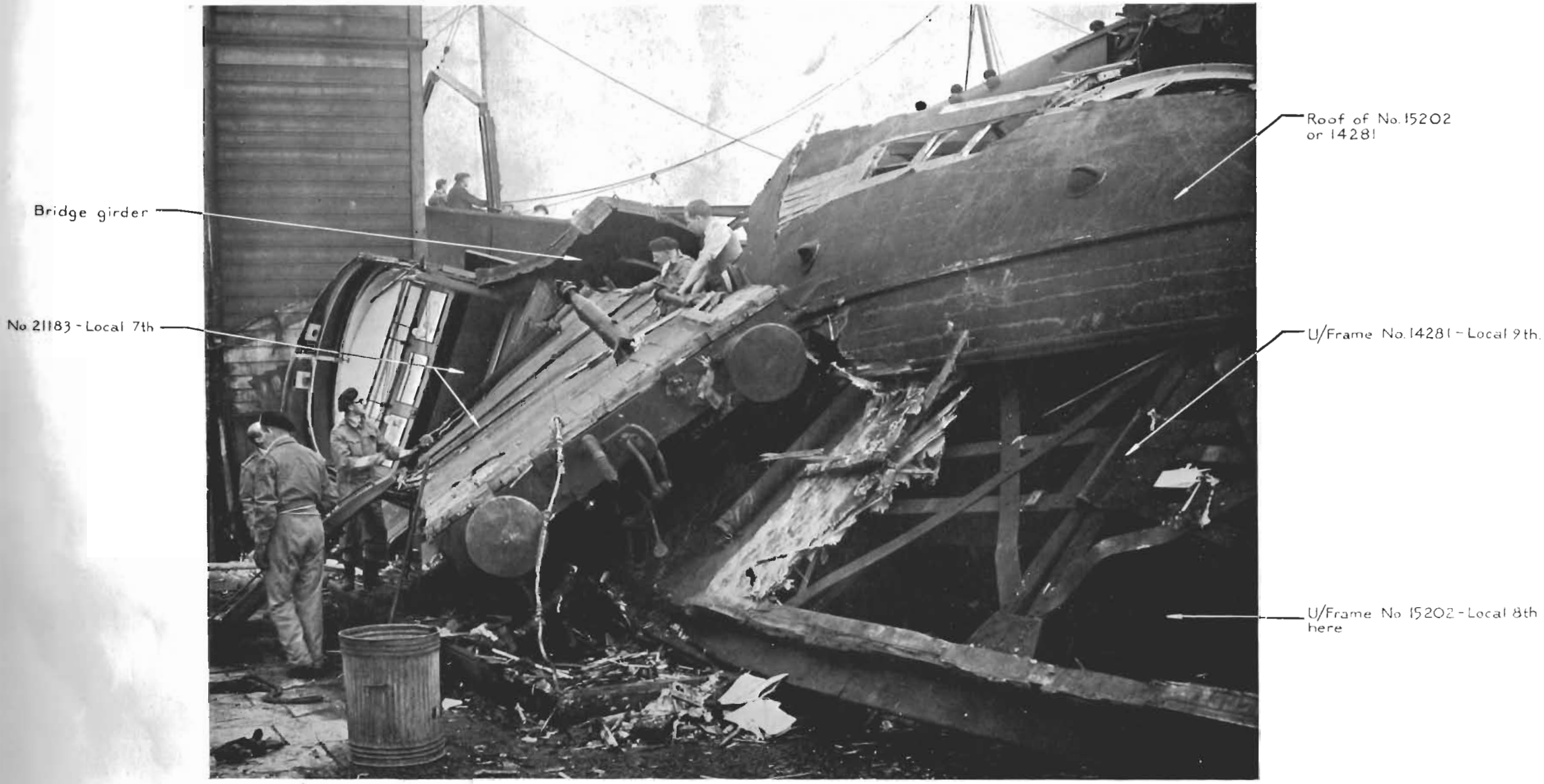
3. ENGINE NO. 46242. *Class* 8.*P.* 8.15 *p.m. Train from Perth* (*para.* 5)



4. ENGINE NO. 45637. *Class 6.P. Leading Engine of Liverpool Train* (*para.* 7)



5. ENGINE NO. 45637. *Class* 6.*P*. *Leading Engine of Liverpool Train* (*para*. 7)

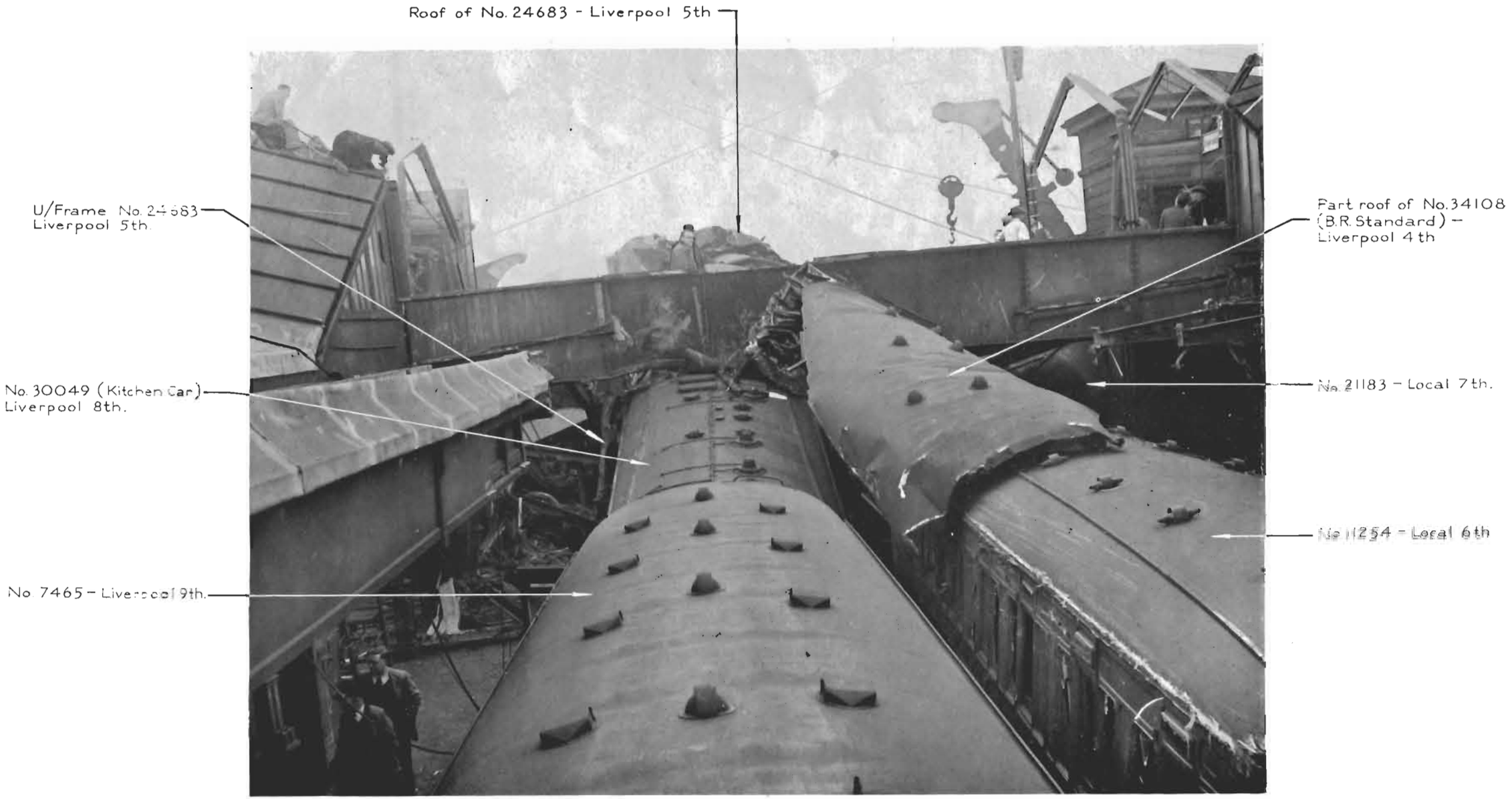


6. *Last Three Vehicles of Local Train* (*para.* 4)

7. *General View of Wreckage from North* (*paras.* 6, 7 *and* 8)

8. *General View of Wreckage from North* (*paras.* 6, 7 *and* 8)

9. *General View of Wreckage of Liverpool Train from Electric Lines* (*paras.* 7 *and* 8)



10. *View from South of Footbridge* (*paras.* 4 *and* 8)

11. *View of 6th and 7th Coaches of Liverpool Train from Up Fast Platform* (*para.* 8)

12. *View looking Northward from Footbridge (para. 8)*

He said that there was a large crowd of passengers waiting for the train, especially at the London end of the platform where he was standing when the first collision occurred. He estimated that the train had been at the platform for " round about a minute ", and he had already shut some doors. Some passengers were thrown down when the local train was thrust forward by the collision, and so far as he could recollect the Liverpool express was passing under the road bridge at almost the same moment.

Mr. Rolinson then made his way to the signal box and he signed the register there at 8.28 a.m. He said that Signalman Armitage was " deathly white " and very upset, and he helped him out of the box to sit on the steps to get some air. He satisfied himself that Armitage had sent the Obstruction Danger signal for all four lines, but he had said that he had no other conversation with him, and this was confirmed by Mr. Abraham who was in the signal box at the same time. After that Mr. Rolinson occupied himself with the rescue work.

60. Station Foreman H. E. Foskett was on the 6.0 a.m. to 2.0 p.m. shift, and one of his duties that morning was to count the passengers joining and leaving the Up local trains, as a census was being taken. He said that he was in his office on the Up Fast platform at about 8.5 a.m. when the signalman had telephoned to ask him to warn the waiting passengers to stand back as an express (the 10.20 p.m. from Glasgow) was to run through before the local train arrived; he added that this was quite often done whatever the weather conditions. He remembered having looked at the clock as he came out of his office, and at the same time he saw the signalman standing at the window of the box (150 yards away) though he could not recognise who it was. As has been stated, the Glasgow express went through at 8.11 a.m. and Foskett said " it was going nicely. About the usual speed through Harrow ".

He was at the foot of the bridge stairs counting the passengers as the local train came in, and when the collision occurred he had noted that 332 passengers had come down the stairs to join the train and that 20 had gone up. He thought that the train had been standing at the platform for about its booked time of two minutes, and he was just about to step out on to the platform and see that everything was right for giving the tip to the guard. He was certain that the train was still stationary, and so was Mr. Rolinson, though Mr. L. Rowlands, who was in the train, (see page 2) said that it was just moving away when he felt the first heavy jolt.

Foskett was one of the first to send a telephone call for emergency assistance. In describing the visibility generally he said that it was about 50 yards at about 6.45 a.m. when it became light, and that at 8.0 a.m. the fog seemed to be clearing to the South " and coming and going to the North ".

61. Mr. R. W. Hall, who is a Traffic Apprentice, aged 26, was also in the local train. He stated that he went to the signal box about 18 minutes after the accident and he met Mr. Rolinson coming out. He confirmed the position of the levers as Mr. Williams had stated (para. 55). He found Signalman Armitage in a very shocked condition and on being asked whether he had any particular conversation with him, Mr. Hall replied " No, I have always thought him sensitive and ready to take offence at remarks made by people. I should imagine him to take it very hard ".

62. Ganger A. H. Payne's length extended through Harrow station as far northward as the 12 mile post. His gang consisted of three men besides himself, only one of whom, Lengthman Honour, was passed in fogsignalling duties, and he was allocated as tail lamp man at Harrow No. 1 box; the other two men, one of whom was Polish, had only been a short time with the gang. Payne said that after booking on duty at 7.30 a.m., he put his gang to work in the sidings owing to the fog. He then went off to examine his length as far as the 12 mile post and called at the signal box on his way. He recollected that the signalman had asked him if a fogman was available and he said that it was his intention to send Honour to the box as tail lamp man when he got back to the station sidings after walking his length. On being asked whether he thought that there should have been a fogman at the Up Fast Outer Home, he replied, " Yes, if one was available ", but he added that the fog was " coming in spasms ".

Payne said that he had gone to the box just after 8.0 a.m., but it must have been well before that because he remembered that a train passed him on the Up Slow while he was walking northward, and the train register showed that this could have only been a local train which passed Harrow at 8.1 a.m. He could not recollect having seen any other trains, although the Glasgow express, the 7.31 a.m. local train and finally the Perth express must have passed him on the Up lines, also the freight train on the Down Slow. He did not hear the crash. Payne also made some statements about the visibility, but they were so inconsistent that they were valueless. He gave no satisfactory explanation why he had not sent Lengthman Honour to report to the box directly he came on duty at 7.30 a.m. in accordance with the usual practice in foggy weather.

63. Ganger A. Turney, of the next length to the North, booked on duty at Headstone Lane at 7.30 a.m. Soon after that he began to walk his length southward, and he said that the visibility at Headstone Lane at that time was about 100 yards, but that it was rather clearer as he got towards the 12 mile post. He said that there were four men besides himself in his gang at the time of the accident, but that two of them had left a week later. None of them except himself had been trained in fogsignalling duties and he remarked that men were coming and going all the time.

Permanent Way Inspector C. E. Penny and District Signalman's Inspector E. Short, spoke of the difficulty of manning the fog posts when required, as few men stayed with the maintenance gangs for any length of time. Mr. Short observed that out of the two gangs in the neighbourhood of Harrow only one man was available. He considered that in these circumstances the tail lamp post at the box should be given priority, as the question of a fogman at the Outer Home was covered by the acceptance regulations, and he was supported in this by the District Operating Superintendent, Mr. Cox.

X. Summary of Evidence on Visibility

64. In neighbourhood of Harrow No. 1 Up Distant Signals:—

Ganger Turney	7.40 a.m.	100 yards at Headstone Lane. Became clearer as he walked towards Harrow.
Driver Halliburton ... ... (Glasgow train)	8.8 a.m.	Saw Up Fast Distant with no difficulty at about 50 yards or rather more than two engine lengths.
Driver Payne ... ... (Local train)	8.15 a.m.	Saw Up Slow Distant with no difficulty at about 50 yards.
Signal Lineman Dell ... ... (In front van of Local train)	8.15 a.m.	Saw Up Slow Distant at 20 yards only owing to engine in front of him. Estimated that visibility in direct line might have been 200 yards.

65. In neighbourhood of Harrow No. 1 signal box. Sunrise was at 7.11 a.m. (B.S.T.).

Signalman Armitage ... ... (In Harrow No. 1 box)	6.0 a.m.	Back lights of Up Slow Home signals used as fog object (303 yards) visible.
	6.35 a.m. (recorded, and Control Office informed by telephone)	Back lights of Up Slow Home signals obscured. Commenced fog block working.
	8.0 a.m.	Weather clearing rapidly and sun shining.
	8.10 a.m. (recorded, and Control Office informed by telephone)	Up Slow Home signals visible. Reverted to normal block working.
Stationmaster Rolinson ... (At station)	8.10 a.m.	About 200 yards both ways. Sun just appearing above the mist.
Station Foreman Foskett ... (At station)	6.45 a.m.	50 yards.
	8.0 a.m.	Clearing to the South and coming and going to the North.
	8.5 a.m.	Saw signalman at box window 150 yards away (measured) but could not recognise who it was.
Driver Brown ... ... (Down Freight train)	8.11 a.m.	200 yards at most.
Guard Starmer ... ... (Down Freight train).	8.11 a.m.	200 yards.
Driver Payne ... ... (Local train)	8.16 a.m.	Patchy. Hazy rather than foggy. Sun breaking through. A good deal clearer than at Distant signal. Saw Home signal "off" at 150–200 yards. Difficult to judge when running towards an object.
Guard Merritt ... ... (Local train)	8.16 a.m.	Saw engine (140 yards from his van) as it passed Home signal.
Signal Lineman Dell ... ... (In front van of Local train)	8.16 a.m.	Patchy. Quite clear approaching Harrow. Visibility ¼ mile and sun breaking through.
Mr. Williams ... ... (Signal and Telecommunications Engineer) (as he got out of the local train after the collision)	8.20 a.m.	A "half fog". 200–300 yards and clearing.
Guard Kent ... ... (As he got out of the Perth train after the collision and looked back)	8.20 a.m.	"A lot more" than 100 yards.

All times are approximate except those recorded.

XI. Time of Accident

66. The time of the accident was established with some exactitude as all the station clocks were stopped by the shock. A statement was made by the clerk in the East booking office that the master pendulum clock there stopped at 8.18 a.m., and a photograph of one of the platform clocks, which is controlled electrically by the master clock, showed that it had stopped between 8.18½ and 8.19 a.m. The independent turret clock, which is kept one minute fast, stopped at 8.19½ a.m. (see photograph 9). It was stated by the Signal and Telecommunications staff that the Harrow clocks seldom required adjustment, and it seems reasonable to conclude that the accident occurred at 8.18½ a.m.

It will be recollected that Signalman Armitage had booked the arrival time of the local train as 8.17 a.m., and the time of the Obstruction Danger signal as 8.18 a.m. (The signal box clock was correct.) As has been mentioned times are entered in the train register to the nearest minute.

XII. Conclusions

67. For the reasons given below, I am entirely satisfied that the first collision resulted when Driver R. S. Jones did not reduce the speed of the Perth train in obedience to the Harrow No. 1 Up Fast Distant signal at caution, and subsequently passed the Outer and Inner Homes at danger. Having regard to the evidence of Guard Kent, and the time it would have taken for the vacuum to be destroyed throughout the train, it is probable that Driver Jones' last minute brake application was made before the engine reached the detonators at the signal box, possibly when he caught sight of the Inner Home signal at danger, or he may have seen the obstruction ahead. I am also satisfied that no responsibility should rest with Signalman Armitage, and once the first collision had occurred neither he nor the enginemen had any opportunity to prevent the Down Liverpool express from running into the wreckage at speed.

68. Consideration was given very soon after the accident to whether Driver Jones might have been faced unfairly by the two stop signals at danger in poor visibility *after* he had seen the Distant at clear as the result of a last minute change of intention by Signalman Armitage as to the precedence of the two trains. The recorded block times cannot be regarded as reliable evidence on this point and recourse was had to a simple time and distance calculation.

It was necessary first of all to determine the minimum interval which could have elapsed between the time when Driver Payne, of the local train, had first seen the Up Slow to Up Fast Home "off" and the time of the collision. A series of representative tests showed that the local train would have taken between 80 and 90 seconds to run for 727 yards through the crossover to its stop at the platform from the moment when the engine struck the 200 yard berth track circuit (No. 2787) in rear of the Up Slow Home, and this, of course, has to be added to the time for which the local train had been standing at the platform when the first collision took place.

While the times recorded in paragraph 66 above afford no firm base for determining the time for which the local train had been standing, I do not regard them as inconsistent with the statements of Driver Payne (perhaps 2 minutes), Fireman Hine (perhaps 1½ minutes), Station Foreman Foskett (about its booked time of 2 minutes) and Mr. Rolinson (about 1 minute). I am satisfied from all the verbal and circumstantial evidence on this point that the local train had been standing for not less than 1 minute.

69. It follows that the crossover, which was run through in the reversed position by the Perth express, could not have been placed in that position, and the Up Slow to Up Fast Home cleared, less than 80 + 60 or 140 seconds before the collision. It was also shown by a test in my presence that at least 20 seconds would have been occupied by the 10 lever movements required to restore the Up Fast signals, commencing with the Distant, reverse the crossover and clear the Up Slow to Up Fast Home. The Up Fast Distant could not therefore have been restored to caution less than 160 seconds before the collision. Assuming that the Perth express was travelling at 50 m.p.h., it would have been 3,911 yards from the point of collision at that moment, or 1,809 yards from the Distant itself, a long way outside its range of view even in clear weather—see paragraphs 21 and 23.

The assumption of 50 m.p.h. for the speed of the Perth express on the falling gradient is, if anything, on the conservative side considering the nature and extent of the wreckage and the evidence of Guard Kent (50–55 m.p.h.) and of the signalmen at Bushey (60 m.p.h.) and Hatch End (55 m.p.h.); I do not however pay much attention to Signalman Armitage's statement that its speed was far in excess of that of the Glasgow express which preceded it, as his estimate was made at a moment of considerable stress. Moreover, there is a good margin of proof in the time and distance calculation when it is considered that the maximum distance at which the Harrow No. 1 Up Fast Distant can be seen on the curve is 733 yards in clear weather. It is certain that the visibility was much less than that at the time.

70. There was no fault in the mechanical locking, and I conclude that the levers of the Up Fast Inner and Outer Homes, *and* of the Up Fast Distant were normal in the frame when the Distant signal came into view from the engine of the Perth express, probably at a range of about 100 yards, and that they remained so until the collision. I have no hesitation in accepting the statements of Mr. Williams and his staff, after the tests which were made (paragraph 57 and Appendix B) that the circuits and controls of the Up Fast Distant signal were in order. The possibility of a false clear aspect having been shown by that signal as the Perth train approached it can be dismissed, and I have no doubt whatever that it was displaying its main Yellow caution aspect, as also was the Up Slow Distant beside it.

71. Having regard to the foregoing, I consider that there is every confirmation of Signalman Armitage's strongly maintained statements that he had not changed his mind at the last moment as to the precedence of the two trains. The question, however, arises whether he should have given precedence to the local train through the crossover while the Perth express was overtaking it on the Up Fast line—or whether, having done so, he should have allowed the Perth express to approach the Harrow signals at caution and danger which were protecting the occupied junction. In other words, should he have accepted it from Hatch End under the prevailing conditions?

72. On the first point, Armitage was expected to give precedence to the residential trains notwithstanding any further delay which might be caused thereby to late running expresses; he was also expected to keep them to the booked route laid down for them in the working time table. In this particular case

the 7.31 a.m. local train from Tring was booked to run on the Fast line from Harrow to Euston so as to leave the Slow line clear for empty stock movements, and it is clear that Driver Payne realised that he would be diverted to the Fast line at Harrow as a matter of routine although he was running a few minutes late. Armitage had accepted the local train at 8.7 a.m. before he had learnt anything of the approach of the Perth express, but as he had already cleared the Up Fast signals for the Glasgow express, he was unable to reverse the crossover until the latter had passed.

I see no reason to doubt that he did in fact reverse the crossover for the movement from Up Slow to Up Fast directly he was in a position to do so, i.e. after the Up Glasgow express and the Down freight train had cleared it at approximately 8.11 a.m., and probably, as he said, after he had been reminded of the local train by the Train Approaching signal; the time of this signal was not recorded, but in the ordinary course it would have been transmitted forward to Harrow when the local train passed Bushey at 8.11 a.m. While he was unable to get the local train accepted by North Wembley at this stage, as the Glasgow express did not clear the section until 8.14 a.m., his natural course in the meantime would have been to set the crossover to admit it to the platform for its station duties, and it was also stated by Goods Guard Starmer, of the Down freight train (paragraph 45) that the crossover was reversed behind him at or about 8.11 a.m. The local train was accepted by North Wembley at 8.14 a.m., but Armitage waited to clear his signals for it until the engine struck the berth track circuit. The Rules do not require the speed to be checked in this way for a diversion which is booked in the working time table, and so anticipated by the driver, but signalmen often take the additional precaution on their own initiative, and I do not wish to criticise a practice which errs on the safety side.

73. On the matter of the acceptance of the Perth train from Hatch End, the time of which was also recorded as 8.11 a.m., Armitage at that time had " occupied " or " fouled " the trailing junction by reversing the crossover, or was just about to do so. As, however, the intended converging movement was doubly protected by an Inner Home signal at danger *and* an Outer Home at danger 440 yards in rear of it, he was entitled by the Absolute Block Regulations for normal or clear weather working (paragraph 25 (*a*)) to accept a train from Hatch End on to the Up Fast line after he had reversed the crossover—and conversely, he was entitled to reverse the crossover after he had accepted a train on the Up Fast line to the Outer Home signal at danger.

74. No fault can thus be found with Signalman Armitage's conduct in his operation of the traffic, provided that he was justified by the visibility *in the neighbourhood of his box* in accepting the Perth train from Hatch End at 8.11 a.m. under the regulations for normal or clear weather working, i.e. without a fogsignalman at the Outer Home signal *or* a clear 440 yards beyond the Inner Home—see paragraph 24. The question of the visibility *at the Distant signal* is not relevant in this connection, as it was a colour light, and under any conditions of fog could be treated as the equivalent of a semaphore distant with a fogsignalman stationed at it.

75. In reviewing the evidence on the visibility at Harrow No. 1 box and northward from it, which has been summarised in paragraph 65, the tendency to overestimate the density of fog or mist must not be overlooked, and no class of evidence can be less positive than recollections of visibility, though given in perfectly good faith. There is no doubt that the conditions were better towards Harrow than at the Up Distant signals in more open country, but by all accounts the visibility was far from uniform, and it seems that from 8.0 a.m. onwards it was varying from moment to moment and from place to place from 200 yards or less to 300 yards or more, as the fog was dispersing under the growing power of the sun, on which several witnesses were agreed, and was drifting with the light westerly wind.

More than that I cannot say, but I do not consider that Signalman Armitage's statement that he could see the Up Slow Home signals 303 yards from the box at 8.10 a.m. is inconsistent with the estimates given by other witnesses. I do not even exclude the evidence of Driver Payne, although he must have been less than 200 yards from the Up Slow to Up Fast Home signal when it came into his view in the " off " position at about 8.16 a.m., as the signal, according to Armitage, was not cleared until the engine reached the 200 yard berth track circuit. Under the " patchy " conditions, the visibility may have been less at the approach to the signals than it was between the signals and the box.

76. The fact that Armitage had instituted fog block working at 6.35 a.m., half an hour after he had taken duty, suggests that he was fully conscious of his obligations under the acceptance regulations, and I do not disbelieve his statement that he was keeping a careful watch towards the Up Slow Home signals when the fog began to clear round about 8.0 a.m. and that they were within his view at 8.10 a.m. when he resumed normal working, recorded in the register that he had done so, and notified the Control Office by telephone, just as he had reported " Fog On " at 6.35 a.m. Moreover the use of these signals as a fog object gave a good margin over the 200 yards stipulated in the regulations.

77. Generally, Armitage appeared to be an able relief signalman who was thoroughly conversant with the working at Harrow, and his record is very good. I can find no evidence to show that he failed in any way to comply with the regulations in his signalling of the local and Perth trains, and the state of shock in which he was found after the accident should not be held against him. In view of his temperament, which was described as sensitive—and I had the same impression at my Inquiry—I can well understand his reaction to the disaster which had taken place under his eyes. He had complied with the established routine in giving precedence to the local train at the junction, which was protected on the Up Fast by an Outer as well as an Inner Home, and on the question of visibility, a man in his position could only be expected to judge by the distance he could see from the box, as laid down in the regulations. I consider, therefore, that he should be exonerated from all responsibility for the accident.

78. Owing to the very regrettable death of the two men on the footplate, it is only possible to speculate on the circumstances of the human failure which brought about the first collision. Driver Jones was an engineman of considerable experience and mature age with a good record, and it appeared from Guard Kent's statement that he had been driving with proper caution during the journey from Crewe in the fog; he had also proved that he was alert a short time before the accident by the signal stop at Watford (North End) and later still by the acknowledgment which was received by the fogsignalman at the Bushey semaphore distant. Moreover it does not appear that the conditions for some distance beyond were so bad that he should have lost his location in daylight. Owing to the damage to the tender it was impossible to say whether he had taken water at the Bushey troughs, but the troughs themselves are a very definite landmark, and the visibility at Hatch End had improved to about 500 yards by 8.0 a.m.

It is thus reasonable to assume that Driver Jones knew where he was when he was passing Hatch End, and he should also have known from his experience of the route, which was quite recent, that the Harrow No. 1 Up Fast Distant was the next signal which he would have to observe. From the position in which the engine controls were found, I also think it is probable that he had shut off steam after passing the troughs at the head of the long falling gradient, as is often done by the drivers of Up express trains—see paragraph 53.

79. The Harrow Up Distants are only 1,300 yards beyond Hatch End box, but by all accounts the visibility at these signals was not nearly so good as it was at Hatch End. It may have been 100 yards or less, and at 50 m.p.h. they would have been in a driver's view for about four seconds only. This is not a long time, but the colour lights are well sited and focused for observation from the left hand side of an engine, and two other drivers, who were travelling at much the same speed, had no difficulty in seeing them a few minutes earlier, as well as Signal Lineman Dell, who was in the front van of the local train. I have not overlooked that steam and smoke from the freight train on the Down Slow might have hung under and around the Headstone Lane bridge and restricted the view of the Distant signal still further just as the engine of the Perth train passed it, but such happenings are in the ordinary run of a driver's experience and if Driver Jones had been keeping the close and continuous look out which the conditions required, he could hardly have missed an intense colour light which is so conspicuous at short range and was presented so close to his line of sight.

80. His temporary incapacitation by sudden illness seems most unlikely in view of Dr. Teare's report, and a meticulous examination of the engine disclosed no defect which might have distracted his attention; nor was there evidence that a blow back had occurred through the fire hole door. In these circumstances I can only suggest that Driver Jones must have relaxed his concentration on the signals for some unexplained reason, which may have been quite trivial, at any rate during the few seconds for which the Distant signal could have been seen from the engine at the speed he was running in a deceptive patch of denser fog. Having thus missed the Distant he may have continued forward past Headstone Lane station (which was not on his own side), underestimating the distance he had run from Hatch End and still expecting to see the colour light and not the Harrow semaphore stop signals which were at a considerably higher elevation. I have already referred to the possibility that he may have braked when he caught sight of the Inner Home at danger or the local train in front of him, but it also seems that he may have suddenly realised that he had missed the Distant when the signal box and the surroundings of Harrow station came into his view. Fireman Turnock had no special reason to concern himself with the signals after passing the Bushey Distant on the right hand curve, as there was a better view of them from the driver's side.

81. Finally, I think it is unlikely that a green colour light of one of the Up Electric line signals at Headstone Lane could have been mistaken for a clear aspect at the Harrow Up Fast Distant. As I stated in paragraph 23, a certain amount of care is necessary to read the signals correctly at this point, but no more than at many other places where there are parallel lines for the same direction, and in my opinion Driver Jones' professional experience and knowledge of the route should have been sufficient for him to avoid a mistake of this kind. Nor is it probable that he could have been dazzled by the low sun at the Distant signal where the fog was comparatively dense, though it may possibly have affected the background of the two semaphore stop signals,—see paragraph 24.

XIII. Remarks and Recommendations

82. The results of the collision between the two Up trains were aggravated in the first instance by the fact that the local train was more crowded than usual owing to the temporary cancellation of the next local service to Euston. It was still more unfortunate that the Down Liverpool express was approaching so closely that no member of the staff had any opportunity to stop it or check its speed before it struck the wreckage of the first collision, resulting in a final casualty roll which has only once been exceeded in a railway accident in this country.

83. It is impossible to say to what extent the casualties among the passengers of the Perth and local trains were increased by this second collision. So far as could be ascertained, 64 passengers of the total of about 250 in the last three coaches of the local train lost their lives, or about 25 per cent., but the 23 passengers who were known to have been killed in the Perth train represented a much higher proportion of the number in its first three passenger coaches. It seems probable that a good many of the local train passengers were thrown clear on to the platform away from the Down Fast line as the wooden body sides were burst open and shattered by the first impact, while some of the Perth train passengers who had survived it were killed a few seconds later when the destruction of the sheet steel panelled coaches was completed by the coaches of the Liverpool train which overrode them.

Rolling Stock

84. The eight fatalities which were known to have occurred in the Liverpool train itself is a surprisingly small number considering that the leading seven passenger coaches were involved in the wreck. This may be attributed to some extent to the workings of chance and it appears that the diversion of the two engines and the leading three coaches to the left may have lessened the damage to the rest of the train. It is however notable that the 4th and 6th coaches which were built in 1951 and 1952 to the new British Railways standard design, with all-steel welded bodies which were welded to the underframes, both kept their form as integral structures without very severe disturbance of the internal partitions and fittings. The 5th coach which was built in 1950 also had an all-steel body but it was of earlier design and was mounted on a standard London Midland Region underframe in the ordinary way; it was probably one of the first to strike the main body of the wreckage under the footbridge and its underframe and body were destroyed.

85. An exceptional disaster such as this, in which enormous destructive forces were applied to a large number of vehicles from different directions, can give no firm grounds for conclusions on the merits of different types of carriage construction from the safety point of view. I think, however, it is fair to say that the comparatively modern composite coach body, with sheet steel panels and roof and hard wood framing, is not in itself a great deal stronger in structural resistance to collision forces than the older all-timber construction, though it is probable that casualties from splinters are lessened. The heavy steel underframes which have been adopted for all main line stock in recent years can sometimes give considerable protection against the crushing of the vehicle as a whole, but if overriding takes place their resistance is not brought into full play, and in these circumstances a heavy underframe may even add to the destruction by the well known telescoping effect. The all-steel body shell mounted on a normal underframe is a step in advance and has proved its value more than once in collisions where conditions were less severe, but no carriage body for service in this country can be built, even in steel, to withstand the very violent shocks which must have been received by the 5th coach of the Liverpool train.

86. With a strict necessity to save weight, it seems that the right line of approach is to design and build our railway carriages so that the strength of the body and underframe can be developed as a more or less homogeneous structure, each reinforcing the other, so as to enable the best use to be made of all the material to resist shock loads. The new British Railways standard all-steel coaches, of which the underframes alone are nearly twice as strong as any of the Regional designs, go a long way in this direction. Corridor coaches are also provided with rigidly holding central Buckeye couplings which were standardised by the former London and North Eastern and Southern Companies for their main line stock and have proved their value on past occasions in reducing the risks of telescoping; by careful design the weight of a corridor passenger coach has been kept down to 34 tons or less, which is about the maximum which can be accepted in this country where a definite limit is set to haulage power by the restricted loading gauge. I have no doubt that as manufacturing technique is developed, further advances will be made in strength without increase of weight, but design must also take account of ease of repair, and cost cannot be disregarded.

87. No practicable form of carriage construction can be relied on to prevent casualties when heavy trains collide at high speed, as the energy which has to be dissipated in a short time and space is so very great, and this has been shown by recent cases abroad where it is possible to operate steel coaches of very heavy construction. It does seem possible, however, that the wreckage at Harrow might have been less compact, and the killed and injured fewer, if a greater proportion of the rolling stock had been of the latest all-steel type and rigidly coupled.

88. There are now 1,100 coaches of the new standard design in service on British Railways of a total of about 37,000 steam hauled passenger vehicles, although shortage of steel prevented any new construction under the 1952 carriage renewal programme. The steel position is now much better and it is anticipated that the standard coaches will be coming into traffic at the rate of about 1,200 a year from now until 1956, when the arrears of replacement should have been overtaken, and at about 650 a year thereafter. There will thus be a progressive general improvement in the strength of passenger rolling stock, but railway coaches are necessarily built for long life, and some years must elapse before the standard coaches predominate, even in long distance trains. Similarly, there will be a long transition period before Buckeye couplings are in general use with corridor stock on the routes of the former London Midland and Scottish and Great Western Railways on which ordinary screw couplings were standardised.

Marshalling

89. The two bogie vans at the front of the Perth express undoubtedly saved serious damage to the passenger coach marshalled 6th and to the following sleeping car. The value of such protection has been recognised, and instructions were issued to all Regions in 1948 that a brake van or vehicle with a brake compartment at the leading or trailing end should be marshalled at the front or rear of passenger trains wherever practicable. The local train in this case was marshalled with the rear brake compartment at the trailing end of the 7th coach, but as this brake compartment was swept away in the wreckage I would not suggest that any casualties would have been saved if it had been at the extreme rear of the train.

90. It will be noted that the new standard coaches in the Liverpool train were marshalled 4th, 6th and 11th. As time goes on, more and more standard coaches will be mixed with screw-coupled coaches in train formations. They cannot always be marshalled together, but I think that this should be done wherever it is practicable so that advantage can be taken of their Buckeye couplings.

Operating and Rules and Regulations

91. The late running of the three trains contributed to the accident only in the sense that it brought them into proximity quite fortuitously at the time and place, and the short interval between the two Up trains required one of them to be held at signals so as to give precedence to the other in the ordinary course of junction working. There are good reasons for giving precedence to the London residential trains in the morning when main line expresses are running late, as is unavoidable in foggy weather, and in order to keep them as nearly as possible to time and avoid the dislocation of other movements, it is necessary to hold them to their planned routes on the Fast and Slow lines at the expense of checks or stops to the long distance expresses, either at the crossover junctions or in the ordinary course of block working. It should be clearly understood, however, that these are matters which affect the efficiency of traffic operation rather than safety. *It is fundamental that the safety of railway traffic must depend at all times on the obedience to signals.*

92. By permitting the acceptance of a train when a junction in its path is occupied only where there is an Outer as well as an Inner Home signal, I consider that the Absolute Block Regulations go as far as is reasonably practicable to provide for ordinary misjudgment by drivers in clear weather. The circumstances at Harrow were in fact no different from those at the many converging junctions in the country which are equipped with Outer Home signals, whether they are geographical junctions or junctions between parallel lines on the same formation. As has been stated, such additional Homes have been provided specially to give a margin for overrunning so that trains may be accepted freely, but no such margin can allow for disregard of all the signals. Detonator placers worked from the signal box can sometimes be a very valuable safeguard in such an emergency, and they were used in this case; the distance, however, was much too short for them to have any effect.

93. It is probable that patchy fog in the section contributed to the first collision, although the visibility at Harrow No. 1 box was considerably more than the minimum which is laid down for normal working. Signalmen, however, must of necessity be guided by arbitrary rules which cannot provide for every contingency, and the Rules and Regulations for train working in fog have proved adequate in practice with the aid of the professional skill and care which is displayed by engine drivers throughout the country on the vast majority of occasions. The way to guard against the exceptional case of human failure of the kind which occurred at Harrow does not lie in making the regulations more restrictive, with consequent adverse effect on traffic movement, but in reinforcing the vigilance of drivers by apparatus which provides a positive link between the wayside signals and the footplate. This is known as Automatic Train Control. The type known as " Warning Control " which gives an audible warning in the cab and a brake application when a Distant signal is passed at caution has been installed on the lines of the former Great Western Railway for many years, and is in use on the Tilbury line of the former London Midland and Scottish Railway; as will be seen later there are now firm prospects of its extension to other routes on a comprehensive scale.

Automatic Train Control

94. It will be seen from Appendix F that in the 41 years 1912–1952, Formal Inquiries were held into 640 Train Accidents in which 1,416 persons were killed. Of these accidents, 66, or rather more than 10 per cent., might have been prevented or mitigated by Automatic Train Control of Warning type, but it will be noted that the fatalities which might have been saved were 28 per cent. of the 41-year total, or 399 lives in all, including 112 at Harrow.

The much greater proportion of the fatalities is not fortuitous, as Warning Control affords valuable protection against failure to act on the Distant signal at Caution, which may well lead to a collision or turnout derailment at high speed with very serious consequences, experience having shown that if speed is not reduced when the Distant is passed at caution there is a grave risk that subsequent stop signals may also be disregarded. The high value of Warning Control under main line conditions is also emphasised by the fact that if more elaborate and very much more costly forms of apparatus, such as continuous cab signals, speed control or train stops had been in use as well as Warning Control, the proportion of fatalities which might have been saved would only have risen from 28 per cent. to 36 per cent.

That, in short, is the case for Warning Control.

The view is generally held that Warning Control alone is best suited to the *main lines* of this country, although train stop control is essential and is provided under the special conditions of the London Transport and other similar railways. This view found its expression in the following reference to Automatic Train Control which was included in the Requirements of the Minister of Transport when they were revised in 1950:—

> " Equipment of train-stop type, with suitable proving controls, to be provided on urban electric railways in tube or tunnel, and on their extensions in the open. An approved form of equipment of Warning type for distant and multi-aspect signals is desirable on important main lines."

95. For many years before that the Government, acting on recommendations of the Inspecting Officers of Railways, had urged that the fullest consideration should be given by the Railways to the extension of Automatic Train Control, and special Committees were appointed in 1922 and 1927 to review the question, the latter under the Chairmanship of Colonel Sir John Pringle, who was then Chief Inspecting Officer. The " Pringle Committee " reported in 1930 and recommended increasing safety by direct (automatic) and indirect methods, with a general preference for the former and emphasis on the contact system which the Great Western Railway had begun to develop in 1905, and which was already in fairly extensive use. The Committee took note, however, of the non-contact magnetic " Hudd " system and suggested that it

should be tried under working conditions. With regard to indirect methods, the Committee included recommendations for increasing the illuminative and penetrative power of signal lights and the extension of certain types of block control to prevent errors by signalmen.

96. The Report was referred to the Railway Companies, but except for the Great Western, they did not consider that Automatic Train Control, which would require apparatus on the train, was justified on account of the great expense and the small number of accidents which it would prevent, and they proposed that indirect methods should be fully developed. They agreed, however, that further exploration of Automatic Train Control generally was desirable, pointing out that the Great Western system was already 20 years old, and that trials with more modern apparatus were in progress.

97. In 1931 and 1932 trials were carried out with the Hudd system by the Southern and London Midland and Scottish Railways, and in 1937 the latter Company proceeded to instal it on their London Tilbury and Southend section and equipped 150 locomotives for the purpose. This installation was finally approved by the Minister in 1947, on the recommendation of the Chief Inspecting Officer of Railways. The system has since worked satisfactorily in all weathers. In the meantime the Great Western Railway had been steadily extending their contact system, and on the outbreak of war in 1939 the great majority of their main line mileage and practically all their locomotives had been equipped. The London and North Eastern railway had kept in touch with the London Midland and Scottish trials and in 1938, after the serious collision at Castlecary, were beginning to instal the Hudd system between Edinburgh and Glasgow, but the work was stopped by the war.

The Southern Railway on the other hand, while satisfied with the results which had been gained, decided not to proceed further with the matter at that time, preferring to spend their money on colour light signalling with continuous track circuiting, the heavy cost of which was justified by their intense electric passenger services; they maintained with some justification that the arresting effect of a succession of colour light signals made Automatic Train Control less necessary, and that track circuiting was a strong safeguard against signalmen's mistakes which could not be prevented by Automatic Train Control.

98. The subject was again brought into prominence by the serious accident at Bourne End in 1945, where a colour light Distant signal was disregarded or misinterpreted in daylight and clear weather. The Report of Lieutenant-Colonel Sir Alan Mount, then Chief Inspecting Officer, included a strong recommendation for the application of Warning Control to main lines, and the Railway Companies were asked to deal specially with this and other items in submitting to the Minister their proposals on the recommendations of the report. They replied in December, 1947, through the Secretary of the Railway Clearing House, and the letter contained the following paragraph:—

> " It should be pointed out that, apart from the question of finance, the general installation of Automatic Train Control, even of the warning type, on main lines where this does not already exist, would occupy a considerable time and employ a large number of skilled men. The supply of such staff is strictly limited, and its employment on this installation would therefore necessarily delay the execution of other work such as the modernisation of signalling, the extension of track circuiting and other similar works."

99. That was the general position when the British Transport Commission and the Railway Executive assumed control on 1st January, 1948. In the meantime another serious accident had occurred at Goswick where a semaphore Distant was ignored at caution, and Sir Alan Mount concluded his Annual Report for 1947 with a reference to Automatic Train Control in the following terms:—

> " There are substantial grounds for the extension of such equipment, and it deserves high priority in relation to other operating and signalling improvements, particularly as the majority of Railway mileage is likely to remain signalled under the semaphore system for a long time."

100. It will have been noted that there were two systems of Warning Control in established day to day service on the vesting date. By far the most extensive was the Great Western contact system which was in use on 1,356 miles of route. It works by means of a fixed insulated ramp at the Distant signal by which a plunger on the locomotive is raised. When the distant is at caution the ramp is " dead " and the raising of the plunger sounds a siren in the cab and gives an application of the brake which can be cancelled by the driver. With the distant at clear, a small electric current is applied to the ramp, which prevents the siren and brake from acting, and causes a bell to sound in the cab; the current is returned through the running rails.

The Hudd system, as modified by the London Midland and Scottish Railway, was in use on 37 route miles between Fenchurch Street, Tilbury and Southend. It is a magnetic system which does not depend on physical contact. A permanent magnet, followed at a short distance by an electro-magnet, is located between the rails at the Distant signal. With the distant at caution, the electro-magnet is not energised, and the permanent magnet reverses inductively the armature of a receiver under the locomotive; reversal of the armature opens a small valve to reduce the vacuum in a pilot reservoir, which in turn sounds a siren and gives a cancellable brake application, as in the Great Western system.

With the Distant at clear the electro-magnet is energised to an opposite polarity. The siren begins to sound at the permanent magnet, but it is quickly suppressed as the receiver armature is restored to normal by the electro-magnet before the brake can take effect. The equipment operates pneumatically, and there are no electric circuits on the engine. The audible signals on the footplate, namely a long sound of the siren for caution and a short sound of the same note for clear are not nearly so distinctive as the siren and bell of the Great Western system.

The position in the Western Region and on the Tilbury and Southend line remains unchanged today, with a total of 1,393 route miles equipped with Warning Control.

101. After some small scale comparative trials early in 1948, and discussions with the Inspecting Officers, the Railway Executive put forward tentative proposals for a programme to extend Warning Control on main line routes based on one or another of the two systems. They considered that it should be initiated as soon as circumstances would allow, and envisaged an expenditure of some £6 millions staged over six years, but they indicated that the technical problem was not fully solved and that further research was necessary. They also recommended a programme of the same order for the extension of track circuiting and block controls to prevent errors by signalmen. The desirability of all these measures was accepted in principle by the Commission, as was indicated by their published report for 1948.

102. The Railway Executive then gave their consideration to the merits of the two systems. At first they were inclined to favour the Great Western contact system which had operated successfully for many years under steam traction, but subsequent tests with it showed that there was a serious risk of false indications by stray earth currents on lines electrified either with conductor rails or overhead collection; it was also found that there was insufficient clearance between the ramps and the motor cases of multiple unit electric trains. These alone were felt to be important objections to the adoption of the system as a long term future standard for all forms of traction, and after reviewing the question further the Executive also considered that it would be unwise to standardise a system in which heavy mechanical parts were brought into contact with each other at a time when more modern methods of " pick-up " were available; other objections of less moment were also mentioned, including the interference of the ramps with snow ploughs under severe conditions in the North and difficulties of adapting the equipment to fit the variety of cab layouts in other Regions. Although the Hudd system embodied the non-contact principle which was desired, it was not considered wholly satisfactory, mainly because there was not sufficient differentiation between the caution and clear indications.

After a series of meetings with the Inspecting Officers, the Railway Executive proposed in August, 1948, that apparatus combining the best features of the two systems should be developed. After examining a sketch design, the Inspecting Officers informed the Executive that they saw no inherent objection to it, subject to unquestioned proof of its reliability and efficiency in large scale trials for which they suggested at least 12 months would be required. The Inspecting Officers, however, expressed the strong opinion that the Great Western contact system which was already well proven should not be discarded without thorough investigation of means to protect the ramp against false energisation in electrified areas.

103. The Railway Executive after further consideration decided to develop the " compromise " apparatus, the first tests of which were carried out in the spring of 1949, and the results were sufficiently encouraging to justify a large scale trial under fast running main line conditions. The Down main line between Barnet and Huntingdon on the East Coast route to Scotland was selected for the purpose and it was decided to equip 65 locomotives. Track magnets and engine receiver units supplied before the war for use in Scotland were modified for these trials, and Western Region cab units were sent to signalling contractors for modification and fitting of relays.

Good progress was made with installing the track equipment, but there was considerable delay in the supply of the modified cab equipment and, as the first few fitted engines came into service, it was found that the modified Great Western cab equipment could not give sufficient braking force with the different type of brake system in use in the Eastern Region; this trouble was eventually overcome by further modification of the cab equipment on the " vacuum " side. Difficulty was also experienced in locating the various components in the Eastern Region cabs where they could be best protected from vibration and the ingress of dirt and dust. As a result, the trials did not get into full swing until December, 1950, when 54 engines had been fitted with a modified apparatus.

104. The trials continued during 1951, but the alteration of the original Hudd-type receiver unit to work electrically introduced many technical problems, although it had already proved its reliability on the Tilbury line under pneumatic operation. There was no great difficulty with the track equipment, but the electrical equipment in the cab was necessarily more complex than the standard Great Western type and a succession of safety side failures proved very difficult to trace to their source and eliminate.

The Executive therefore decided in April, 1951, to appoint a small committee of technical officers to carry out a thorough investigation on more systematic lines. Special testing apparatus was devised by the committee which proved very valuable in tracing the source of each failure and they were eliminated one by one by minor changes of design and by improving the workmanship of wiring and other details. Further failures which occurred in the first few months of 1952 were more easily dealt with, and by August, 1952, drawings for what was hoped would be the final prototype design were completed and the first set was fitted to a locomotive and put into service on 17th October, 1952. In the meantime the accident at Harrow had occurred.

105. By the end of March 1953, 54 locomotives had been fitted with the final prototype design. The details of its working were thoroughly examined by the Inspecting Officers of Railways who witnessed its working on two occasions in March and April from the footplate of an engine hauling a 12-coach train between King's Cross and Huntingdon. On both of these trips the equipment operated satisfactorily at all of the semaphore distants and the multi-aspect colour light signal locations which were passed at caution and clear; it stopped the train within a safe distance with no action by the driver when an Outer Distant at caution was passed at 93 m.p.h., although the regulator was left open during the stop with the reversing gear at 35 per cent. cut off.

106. This Report is not the place for a detailed technical description of the apparatus as finally designed, but the following is a brief summary of its layout and functioning from the point of view of train operation. The track equipment, consisting of a permanent magnet followed closely by an electro-magnet, is situated approximately 200 yards on the approach side of each semaphore distant and multi-aspect colour light signal. Semaphore stop signals are not equipped. A bell is sounded in the cab for 2–4 seconds when a semaphore distant is clear or a multi-aspect signal is showing Green. When a semaphore distant is at caution or a multi-aspect colour light is at Double Yellow, Yellow or Red, the siren sounds and a brake application commences. The siren and brake can be cancelled by the driver as proof that he is alert, but an attempt to forestall the warning by premature operation of the cancelling handle can only result in a brake application. When the cancelling handle has been used a visual indication appears in front of the driver, and remains until it is reset to normal as the engine passes the next set of track apparatus. This valuable reminder is a feature of the London Midland Scottish system, but is not available in the Great Western system.

107. In my opinion, the apparatus should do all that is required of it in accordance with the principles of Warning Control, and there should be no objection to the same footplate indication for the caution and danger indications of a multi-aspect signal, bearing in mind that Automatic Train Control must always be regarded *as an auxiliary to personal observation of the signals, and not as a substitute for it.* The location of the track apparatus 200 yards before reaching the signal gives the necessary warning in good time, and in multi-aspect areas no driver, except in a sudden emergency, will encounter a signal at Red without having received an audible warning for the Yellow aspect of the signal at rear, of which he will be reminded by the cancellation indicator while he is running between the two signals. I consider that, from the safety point of view, there is no need for differentiation on the footplate between the Yellow and Double Yellow indications at a four-aspect signal.

108. Furthermore, from what the Inspecting Officers have seen of the latest prototype apparatus, on the bench and on the road, it appears that the technical principles are satisfactory, and that detailed design has now reached a stage when any unforeseen troubles which may arise should be rectified without undue difficulty. It will, however, have to be very fully tested in day to day service before the Railway Executive can say that they are satisfied beyond any doubt on the complete integrity of design and construction. Trials with this object commenced in April this year with the 54 engines, and the Executive feel that it will be necessary for them to be in full and normal service for at least six months, and that a final decision on the design for large scale production cannot be taken until the results of the trials are assessed. In my view, the period may have to be longer, and thereafter further trials, and laboratory tests to destruction under severe vibration, may be necessary with the production design.

109. The British Transport Commission have now informed the Minister that, on hearing that I, as Chief Inspecting Officer, am completely satisfied with the efficiency and reliability of the system, they will be prepared at once to consider financial authority for a practical programme of installation. The following are the Executive's proposals:—

(1) for a five-year plan at an estimated cost of £7·5 millions, and

(2) for a long term plan which, including the five-year plan, would bring the estimated total cost to £17·3 millions.

The corresponding annual charges are estimated at £1 million and £2·2 millions.

The five-year plan (1) would cover 1,332 miles of route " or such part of it as may be deemed advisable " covering the lines from Euston to Glasgow, King's Cross to Edinburgh, Edinburgh to Glasgow, Euston to Birmingham, Manchester and Liverpool, Liverpool Street to Norwich and Waterloo to Exeter, Southampton and Bournemouth. It is obviously desirable to avoid the dissipation of resources over too many routes at once, and in consequence the five-year plan would probably concentrate first of all on the main East and West Coast routes to Scotland (King's Cross to Edinburgh and Euston to Glasgow). The route priorities proposed are essentially sound, and I refer later to the suggestion by the Commission that the five-year plan should be regarded as a maximum rate of progress having regard to other commitments of the signal engineering staff in new work and maintenance.

The long term plan (2) would cover an additional 3,988 route miles or, including the five-year plan, a total of 5,320 route miles; on its completion 6,713 route miles would have been covered by Warning Control of one type or another, including the 1,393 route miles of the Western Region and the London Tilbury and Southend section which are now equipped. These 6,713 route miles represent nearly 35 per cent. of the British Railways total (19,276 miles) and would include practically all the main lines carrying heavy passenger traffic. The existing proportion in the Western Region is very similar.

Thus, after all these years, there are now firm prospects that work will be started on the extension of Warning Control to all the important routes of the country within a measurable time, but it would be wrong for pressure to be exerted on the Commission or the Executive to embark on a very costly programme, *before* the trials are completed to the satisfaction of all concerned.

110. In reviewing the history of Automatic Train Control in this country to date which has been summarised in the preceding paragraphs, credit must be given to the former Great Western Railway Company for developing their contact system so early and installing it so extensively without pressure from Government recommendations, and there is no doubt that it contributed in no small measure to their notable safety record which has been continued in the Western Region. The London Midland and Scottish Railway came into the field much later, and on a smaller scale, but their pioneer work with non-contact equipment has now proved very valuable.

Accidents which occurred soon after the war again led to strong recommendations for Warning Contro in the Inquiry Reports, but the Railway Companies were then nearing the end of their existence as independent concerns. They were not in a position to take decisions on such an important matter of technical policy, and the matter was left to the British Transport Commission and the Railway Executive when they assumed control in 1948. The Commission were not slow to decide that the important lines of British Railways should be equipped with Automatic Train Control, and it then became a question of ways and means.

111. The Railway Executive were thus faced with a decision on the system to be adopted. There was the well tried contact system introduced by the Great Western Railway long before inductive methods became feasible with the development of special magnetic steels, and the London Midland and Scottish non-contact system which had only been proved under pneumatic operation with barely sufficient differentiation between the audible signals for caution and clear. The decision was theirs, and I do not think that they can be criticised for adopting the more modern non-contact method of pick-up as a long term future standard for the reasons I have mentioned in paragraph 102 above, despite the obvious attractions of the Great Western system which could be applied at any rate to other steam lines with comparatively little modification. As the London Midland and Scottish system was unacceptable as it stood, this decision required an entirely fresh design of locomotive equipment to give the distinctive Great Western audible signals in the cab in response to the Hudd-type magnetic receiver.

This inevitably led to further delay before a practical programme could be started, but the Executive did not anticipate at first that the development stage would be so prolonged, as the electrical circuits proposed were conventional, and the majority of the components had been well proved in other applications. As it happened, their combination for this special purpose under the rough conditions of locomotive operation gave rise to one problem after another, which had to be solved by continual redesign and manufacture of special parts at a time which was not favourable to such work owing to the export and rearmament programmes and the acute shortage of technical staff, with the result that four years were taken to bring the prototype equipment to its present advanced stage.

I have been furnished with full details of the troubles which were encountered and of the successive steps which were taken to overcome them, and I would not be prepared to say that the experimental period could have been greatly shortened; it should also be recollected that ten years elapsed before the L.M.S. Hudd-type apparatus became thoroughly reliable. Progress, however, seems to have improved when the Railway Executive put the experiments on a more systematic footing by the appointment of their special technical committee in 1951. While it is only natural and proper that the grave consequences of the accident at Harrow should have strengthened the anxiety of the Commission and the Executive to pass on to practical achievement as soon as they can, I would draw attention to the fact that the final prototype design was ready two months before it occurred.

112. There is thus no longer any need to urge the adoption of Automatic Train Control as a standard feature of safety equipment, as is shown by the proposals which have been outlined by the British Transport Commission. They have, however, emphasised that while Automatic Train Control deserves high priority among safety measures, it cannot be given absolute priority over other forms of signalling modernisation, such as the extension of track circuiting and block controls to prevent mistakes by signalmen; these also are included in the Ministry of Transport Requirements for new work and renewals. Progress in this direction has been continuous in recent years, though circumstances have prevented the realisation of the comprehensive programme which, as I have mentioned in paragraph 101, was envisaged by the Railway Executive in 1948. As an example, it will be seen from Section II of this Report that the West Coast main line of the former London Midland and Scottish Railway, on which Harrow is situated, has been more thoroughly equipped with modern signalling controls than any other long distance route in the country; these are one of the " indirect " methods of improving safety recommended by the 1927 Pringle Committee, and statistics confirm that they have been very effective.

This work must, of course, continue as a means of preventing accidents of a numerous class in proportion to the total against which Automatic Train Control can provide no safeguard. Encouragement must also be given to the progressive replacement of semaphores and manual block by colour light signals and continuous track circuiting on lines where traffic is dense and at complicated layouts, as another of the indirect methods. Although these improvements are designed in the main to prevent signalmen's errors, colour lights, including colour light distants in semaphore areas, have done much to help drivers, especially at night and in bad weather, and their number has been increased by 50 per cent. since 1948. Experience, however, has shown that they cannot by any means be regarded as an equivalent alternative to Automatic Train Control.

113. The safety of railway operation depends on many factors, and besides modern signalling equipment they include a good track and soundly constructed and maintained rolling stock. The provision of Automatic Train Control is only one of them, and the proportion of accidents which it can prevent is comparatively small, but they are of a type which can be disastrous to life and very costly to the administration, and therein lies its special value as a safeguard against the consequences of human failure.

In the regulation and execution of an Automatic Train Control programme in relation to the many other calls on the Signal Department for new work and maintenance, much must be left to the judgment of the management. I do not, however, look on Automatic Train Control as a competitor to other signalling development, but as complementary to it, as indeed was the view of the Railway Executive in 1948, when they recommended that a more extensive programme than that now proposed should be completed in six years, and that it should run concurrently with a programme of the same order for the extension of track circuiting and block controls. I would also emphasise that, in contrast to the many effective devices which

have been developed and so widely installed over the years to assist signalmen in their work, the safety of traffic on the majority of our lines still depends on the personal vigilance of the enginemen, as in the earliest days.

The very occasional failures which have occurred give no grounds for loss of confidence in British railway engine drivers as a whole, and there is no reason to believe that the problem has become more urgent in the last few years, notwithstanding the exceptionally tragic results of one such failure at Harrow.* All, however, are agreed that enginemen should be given their share of technical aids to safe working, and I consider that at this late stage there should be no reservations on the rate of progress once the apparatus has been approved. I therefore recommend that all the resources which are available to the Railways for the purpose should be directed to the timely accomplishment of the five-year plan and its subsequent extension as proposed, without prejudice to other necessary signalling work. The estimated first and recurring costs are large, but in my opinion the expenditure should be faced without hesitation, and no financial considerations should be allowed to stand in the way of an ambitious programme, in view especially of the arduous railway conditions in this country with its dense traffic, high speeds and adverse climate in the winter months.

Acknowledgments

114. In concluding this Report, I should mention with appreciation that I have received a large number of letters from the general public embodying suggestions for the improvement of railway safety, many of which included plans for devices to provide Automatic Train Control of one form or another. Some of these suggestions bore evidence of much thought, but none were sufficiently practical to warrant specific reference. Radar has also been mentioned, and radio communication between a moving train and the ground, but in its present state of development radar has no application to the prevention of railway collisions, in spite of its proved success under very different conditions at sea and in the air, nor does experience suggest that radio communication has any value to the safety of train operation, though it has been found useful for certain classes of control work.

115. I also acknowledge the help which I have received from the Railway Executive at all levels in furnishing me with the information which I have required during the course of this investigation.

I have the honour to be,
Sir,
Your obedient Servant,

G. R. S. WILSON,
Lieutenant Colonel.

The Secretary,
Ministry of Transport.

**Note:*—Apart from the 112 persons who lost their lives at Harrow, only one passenger was killed in an accident to a train in 1952.

Composition of Trains

7.31 a.m. train—Tring to Euston

Description Engine 42389 Type 2–6–4 T	*Year Built*	*Body Construction*	*Weight* T.	Cwt.
			86	5
1. Non-corridor 3rd brake—20823 ...	1936	16 gauge steel panels and roof. Timber framing.	28	0
2. ,, ,, 3rd—12005	1937	ditto	30	0
3. ,, ,, 3rd—11780	1936	ditto	29	12
4. ,, ,, 3rd—11550	1932	ditto	28	0
5. ,, ,, 3rd—11129	1928	All timber	27	0
6. ,, ,, 3rd—11254	1929	ditto	26	0
7. ,, ,, 3rd brake—21183 ...	1952	16 gauge steel panels and roof. Timber framing.	28	0
8. ,, ,, 3rd—15202	1921	All timber	26	0
9. ,, ,, 3rd—14281	1916	ditto	24	0
		Total weight of coaches	246	12
		Weight of engine	86	5
		Total weight of train	332	17

8.15 p.m. train—Perth to Euston

Description Engine 46242 Type 4–6–2	*Year Built*	*Body Construction*	*Weight* T.	Cwt.
			161	12
1. Milk van (W.R.)—2931	1940	All timber	25	16
2. Brake van—30437	1925	ditto	23	12
3. Corridor 3rd—1799	1934	16 gauge steel panels and roof. Timber framing.	31	17
4. Corridor 3rd brake—26896 ...	1950	ditto	30	0
5. Corridor composite—4469	1947	ditto	31	0
6. Corridor 3rd—1517	1933	ditto	30	17
7. Composite Sleeping Car—M 723 ...	1936	ditto	43	0
8. Composite Sleeping Car—Sc706M ...	1931	ditto	42	0
9. 3rd Class Sleeping Car—M 589 ...	1933	ditto	37	0
10. 1st Class Sleeping Car—M 370M ...	1936	ditto	41	16
11. Brake van—M 31086	1940	ditto	27	0
		Total weight of coaches	363	18
		Weight of engine	161	12
		Total weight of train	525	10

8.0 a.m. train—Euston to Liverpool and Manchester

Description	*Year Built*	*Body Construction*	*Weight* T.	Cwt.
Engine 45637 Type 4–6–0			133	4
Engine 46202 Type 4–6–2			159	17
			293	1
1. Corridor 3rd brake—26856 ...	1950	16 gauge steel panels and roof. Timber framing.	30	0
2. Corridor composite—4813	1948	ditto	31	0
3. Corridor 1st—1124	1950	ditto	30	0
4. Corridor 3rd brake—34108* ...	1951	16 gauge steel panels and roof. Steel framing. Welded construction. Reinforced ends with Pullman gangways.	34	0
5. Corridor composite—24683 ...	1950	16 gauge steel panels and roof. Steel framing. Welded construction.	29	17
6. Corridor 3rd brake—34287* ...	1952	16 gauge steel panels and roof. Steel framing. Welded construction. Reinforced ends with Pullman gangways.	34	0
7. Vestibule 3rd—27266	1946	16 gauge steel panels and roof. Timber framing.	30	0
8. Kitchen car—30049	1926	ditto	30	0
9. Vestibule 1st—7465	1949	ditto	31	0
10. Corridor 1st—1117	1950	ditto	30	0
11. Corridor 3rd brake—34024* ...	1951	16 gauge steel panels and roof. Steel framing. Welded construction. Reinforced ends with Pullman gangways.	34	0
12. Brake van—30405	1926	All timber	23	12
13. Brake van—30947	1926	ditto	24	0
14. Brake van—(E.R.) 70148E	1928	ditto (Pullman gangways)	26	15
15. Brake van—31755	1928	ditto	26	0
		Total weight of coaches	444	4
		Weight of engines	293	1
		Total weight of train	737	5

* These three vehicles were of British Railways Standard design with all steel bodies welded to strengthened underframes. They and E. Region brake van No. 70148 were fitted with Buckeye couplings, but the screw couplings were in use.

Extracts from Absolute Block Regulations

4. Line Clear or Giving Permission for a Train to Approach

(*a*) Except where instructions to the contrary are issued, the line must not be considered clear, nor must a train be allowed to approach from the box in rear, in accordance with Regulation 3, until the preceding train has passed at least ¼ mile beyond the home signal, or has been shunted or diverted on to another line, and the line, or at a junction the line for which the facing points are set, is clear for at least ¼ mile ahead of the home signal and all the necessary points within this distance have been placed in their proper position for the safety of the approaching train.....

.....

Where an additional home signal is provided at least ¼ mile in rear of the inner home signal, the IS LINE CLEAR signal may be acknowledged when the line is clear to the inner home signal. This permission will not apply during fog or falling snow unless fogsignalmen are on duty at the distant signal and at the outermost home signal.

* * * * * * * * *

(*e*) During fog or falling snow, except where instructions to the contrary are issued, if a fogsignalman is not on duty at the distant signal, the IS LINE CLEAR signal must not be acknowledged in accordance with this Regulation unless the line under the control of the signalman requiring to acknowledge the signal is clear, all the necessary points under his control have been placed in their proper position for the safety of the approaching train, and the Train Out of Section signal or Obstruction Removed signal has been received from the box in advance; where a block indicator worked from that box is provided, such indicator must be in the normal position.

.....

.....

Where an additional home signal is provided at least ¼ mile in rear of the inner home signal, the IS LINE CLEAR signal must not be acknowledged in accordance with this Regulation during fog or falling snow when the line is clear only to the inner home signal unless fogsignalmen are on duty at the distant signal and outermost home signal; if, however, a fogsignalman is on duty at the distant signal only, the IS LINE CLEAR signal may be acknowledged in accordance with this Regulation provided the line is clear for at least ¼ mile ahead of the inner home signal.....

.....

* * * * * * * * *

(*i*) Fogsignalmen will not be employed at continuously lit colour light signals and during fog or falling snow such signals may for the purposes of this Regulation 4 be treated as if fogsignalmen were stationed at them.

EXAMINATIONS AND REPAIRS CARRIED OUT ON ENGINE NO. 46242 WHEN STOPPED AT CAMDEN MOTIVE POWER DEPOT ON THE 28TH/29TH SEPTEMBER 1952 FOR "X" EXAMINATION

EXAMINATIONS

1. General examination by examining fitter and steam test (Before).
2. Tender Tank.
3. Water Pick-up apparatus.
4. Coal pusher.
5. Steam manifold.
6. Oil pipes and oil pipe clips.
7. Axlebox underkeeps.
8. Axlebox trimmings and oil boxes.
9. Grease nipples.
10. Blast pipe, blower ring, ejector exhaust pipe.
11. Drop grate.
12. Hopper ashpan fittings, and damper gear.
13. Speed indicator.
14. Cylinder cocks and gear.
15. Brake gear.
16. Sanding apparatus.
17. Spring gear.
18. Gauge frames, trial taps, and gauge glasses changed.
19. Vacuum drip and relief valves cleaning.
20. Carriage warming apparatus.
21. Vacuum efficiency and driver's brake valve.
22. Steam heating pipes.
23. Steam brake pipes.
24. Injectors.
25. Safety valves and pressure gauge.
26. Blowdown valve.
27. Fusible plugs (examined).
28. Firebox.
29. Smokebox.
30. General examination after "X" examination and repair.
31. Steam test after "X" examination and repair.

REPAIRS

1. Large tubes leaking in firebox. Expanded.
2. Two Steel stays leaking R.H. firebox. Nuts changed.
3. Two Steel stay nuts missing over firehole. Replaced.
4. Hopper ashpan doors making to fit.
5. Baffle plate refitted.
6. Blower valve nut packing. Repacked.
7. Brake stop valve nut packing. Repacked.
8. Right outside steam pipe Expansion Gland. Repacked.
9. Exhaust injector steam control pipe nut under right hand frame tightened up.
10. Tender horn stays loose. Bolts secured.
11. Intermediate buffer guide bolts missing. Bolts renewed.
12. Speedometer bracket loose on foot framing. Secured.
13. Sand pipes and stays loose. Secured.
14. Footframing bolts loose over outside cylinders. Secured.
15. Left hand trailing sand box loose on frames. Secured.
16. Engine brake adjusting. Adjusted.

L.19

REF. LD. 133/27/9/H.

MECHANICAL & ELECTRICAL ENGINEER'S DEPARTMENT,
NELSON STREET,
DERBY.

22nd December, 1952.

HARROW AND WEALDSTONE MISHAP

ENGINE NO. 46242

Below is a summary of the examination which has been carried out very thoroughly and I would state at the outset that nothing has been discovered to indicate any defect at the time of the mishap which might have diverted the driver's attention.

BOILER (General Exam.)

The main damage was concentrated at the smokebox end. The header casting was fractured at the tubeplate flange and had been forced upward. The header flange for the right steampipe had also been smashed off and the pipe was badly flattened and twisted and the smokebox side had folded tightly round it. The left smokebox steam-pipe had snapped off at the weld adjacent to the top flange. The twin outlet snub for the tube cleaner and atomiser steam pipes had snapped off and the cleaner pipe was also broken off behind the cone end.

The upper section of the blower pipe was fractured behind the cone adjacent to the header connection and had also been wrenched out of the bottom flange. The lower section had been wrenched from the " Tee " connection to the twin blast pipes.

The only fracture at the footplate end which would result in a steam blow was that of the left water gauge bottom drain cock which had snapped immediately below the gauge cock body.

It is considered that all the above fractures and damage were *results* of the mishap. There was wastage of the blower pipe at the fracture adjacent to the header but I am of the opinion that actual fracture was caused by the smokebox door and this is borne out by similar damage to the other details.

I am satisfied this pipe was examined and repaired satisfactorily at recent Shoppings.

DETAIL EXAMINATION

Smokebox Steampipes

These were of uniform thickness and there was no indication of local wastage at any point. The average thickness of the left pipe was ·191 in. and the thickness of the right pipe ·198 in. Specified new thickness is ·212 in. (5 SWG).

Tubeplates and Firebox

The firebox was in sound condition, the only slight leakage being apparent from two large and two small tubes.

The front tubeplate was caved in slightly behind the header destroying the seal of the main steampipe and several of the upper tubes.

Super heater Elements

Several of the " downcomers " were very badly twisted, and some were split. A number had been wrenched away at the header seatings. Where possible hydraulic tests were applied individually to each element, but it was impossible to apply the test in all cases due to distortion but all were filled with water and only in one case was there minute leakage at a " piecing up " weld adjacent to the firebox end.

Tubes

All large and small flue tubes were in excellent condition. Each tube was subjected to close visual examination and there was negligible wastage at the tube-plate ends. A hydraulic pressure test was then carried out on each tube after cutting off the split ends. In no case was there any sign of leakage.

Regulator

The regulator operated smoothly from the footplate and examination of the regulator valve and details at the same time showed nothing amiss.

Safety valves

The left back safety valve had been smashed off at the base. The remaining three valves were tested and operated at the following pressures:—

R.H. Back. 240 lbs/sq. in. R.H. Front. 235 lbs/sq. in.
L.H. Front. 225 lbs/sq. in.

S. WILLIAMS, ESQ.,
EUSTON.

HARROW UP FAST DISTANT SIGNAL

Special Investigation and Test Made 4.30–6.30 *p.m.*, 15.10.52

Examination of the circuit controller on lever No. 45 (Up Fast Distant Signal) showed controller bands correctly set and condition of contacts good.

Con box correctly installed so that controller arm would fall to the " ON " position should a breakage of the operating rod occur. All pins and cotters correct.

Examination of the line wires, i.e., open work from Goods Yard " T " pole to signal position—clear of all possible contact and correctly regulated. P.B.J. line wire and bare copper return exists.

Cable from signalbox to " T " pole and lead covered single leads on pole all found to be in good condition.

Relays at the signal location were all found to be free from contact or pivot corrosion and working correctly.

All ground route and signal wiring found to be in good condition.

Tests proved the auxiliary yellow light was functioning correctly.

In view of the above and attached schedule of tests there is no reason to doubt the correct operation of this signal.

D. HEWITT (Area Assistant, Watford Jcn.).
N. P. HENNESSEY, Tech. Asst., Euston H.Q.

HARROW UP FAST DISTANT SIGNAL

Special Investigation and test made, 4.30 *p.m. to* 6.30 *p.m.*, 15.10.52

Insulation Tests made with 1000-volt megger at signalbox—

Weather Damp all tests made with signal lever normal—

G.R. line signalbox links to signal	50,000 ohms
G.R. return signalbox links to signal	50,000 ohms
G.R. line Internal (link box to circuit controller)	250,000 ohms
G.R. return Internal (link box to circuit controller)	250,000 ohms
G.R. line internal B12 to circuit controller	60 megohms
G.R. return internal N12 to circuit controller...	60 megohms
Stray voltage test G.R. line to return between signalbox and signal.	Nil (reading taken on 0·3v. scale of a 1000 ohm per volt meter).
Stray voltage test G.R. line to earth	Nil (reading taken on 0·3v. scale of a 1000 ohm per volt meter).
Stray voltage test return line to earth	Nil (reading taken on 0·3v. scale of a 1000 ohm per volt meter).

Insulation tests made with 1000v. megger at signal—

Yellow/Green signal return wire to earth (H/DGE)	200 megohms
Auxiliary Yellow line (MHGE)...	200 megohms
Auxiliary Yellow return (MHGE)	200 megohms
Green signal line wire (DGE)	Infinity
Yellow signal line wire (HGE)	200 megohms

Insulation resistance between above lines showed infinity in all cases.

AUTOMATIC TRAIN CONTROL

TRAIN ACCIDENTS INTO WHICH GOVERNMENT INQUIRIES WERE HELD

	Inquiries		Accidents which might have been prevented or mitigated by Warning Control			
			Accidents		Fatalities	
	Total Number	Total Fatalities	Number	Per cent. of total	Number	Per cent. of total fatalities
1912–1952 (41 years) ...	640	1,416	66	10	399	28
1912–1921 (*e*) (10 years) ...	193	414 (*a*)	25	13	67	16
1922–1929 (*e*) (8 years) ...	172	183	13	8	28	15
1930–1937 (8 years) ...	112	161 (*b*)	13	12	63	39
1938–1947 (10 years) ...	83	408 (*c*)	12	14	127	31
1948–1952 (5 years) ...	80	250 (*d*)	3	4	114	46

(*a*) Includes 227 killed at Quintinshill in 1915, caused by failure of signalmen; would not have been prevented by A.T.C.

(*b*) Includes Castlecary (1937—35 killed), which might have been prevented by Warning Control.

(*c*) Includes Eccles (1941—23 killed), which might have been prevented by Warning Control.
Includes Bourne End (1945—43 killed), which might have been prevented by Warning Control.
Includes Goswick (1947—28 killed), which might have been prevented by Warning Control.
Includes Norton Fitzwarren (1940—27 killed), which should have been prevented by Warning Control, but driver failed to avail himself of its assistance.

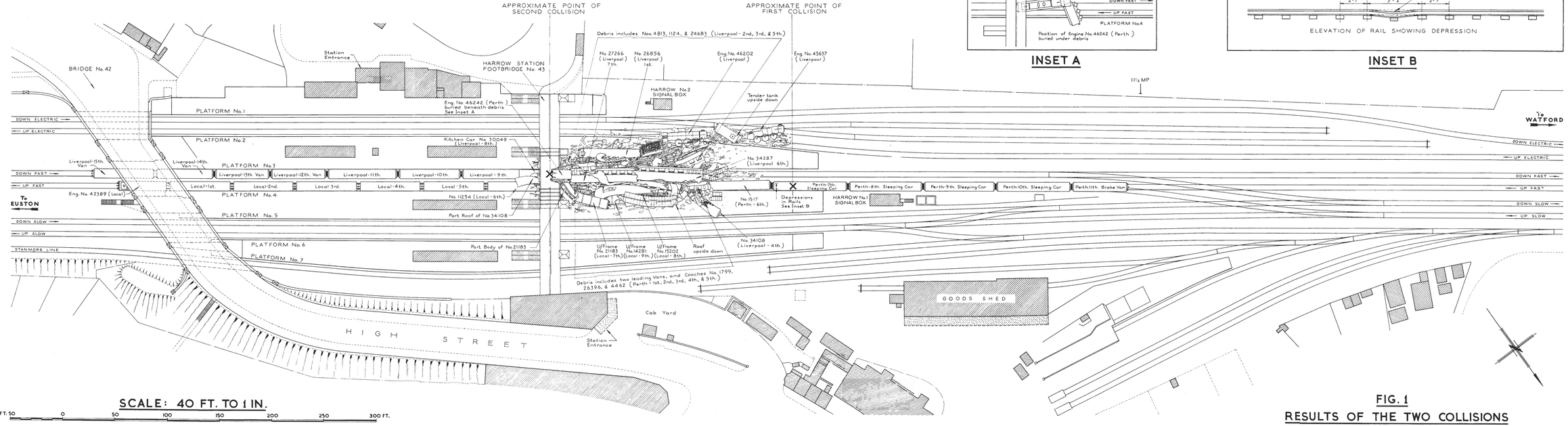
(*d*) Includes Harrow (1952—112 killed), which might have been prevented by Warning Control.

(*e*) Years ended September 30th.

(19584) Wt. 4223—2651 K20 6/53 D.L.

LONDON MIDLAND REGION

ACCIDENT AT HARROW AND WEALDSTONE ON 8th. OCTOBER, 1952



INSET A

INSET B

SCALE: 40 FT. TO 1 IN.

FT. 50 0 50 100 150 200 250 300 FT.

FIG. 1
RESULTS OF THE TWO COLLISIONS

5219-4223-2651-2250-6/53 (M.F.P.)

C.R.O./AM/333

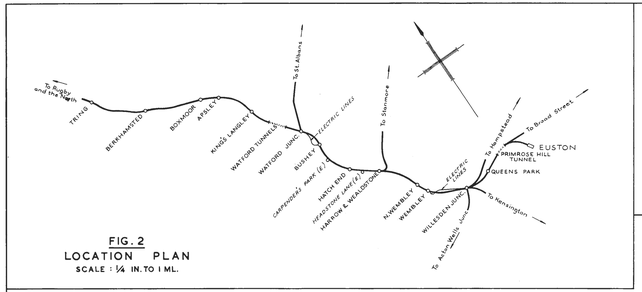


FIG. 2
LOCATION PLAN
SCALE : ¼ IN. TO 1 ML.

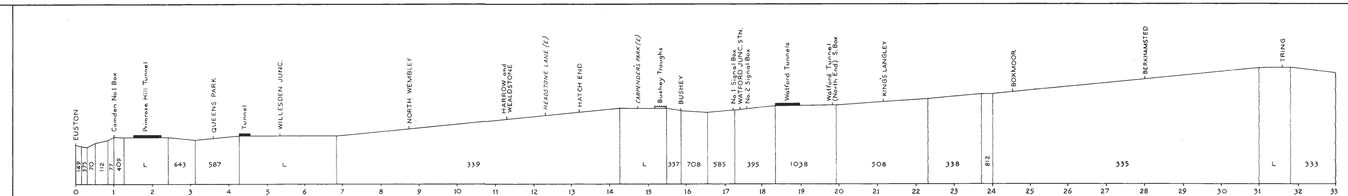


FIG. 3
GRADIENT DIAGRAM – EUSTON TO TRING

FIG. 4
GENERAL SIGNALLING PLAN
Note: Only relevant points, signals, and track circuits are numbered

HORIZONTAL SCALE :– 132 FEET TO 1 INCH

Ft. 100 50 0 100 200 300 400 500 ft.

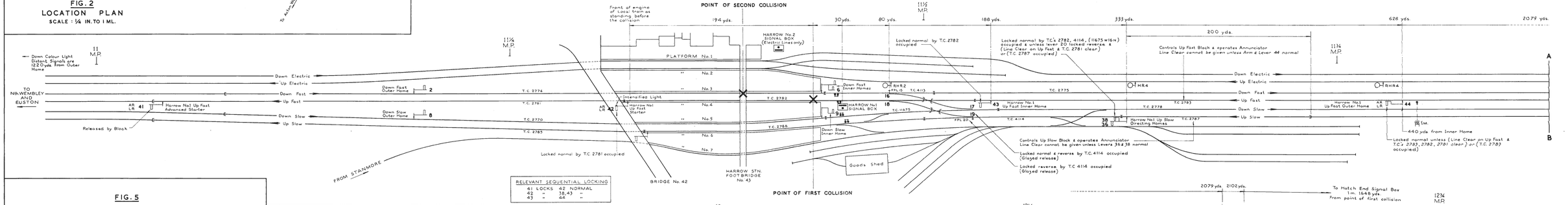
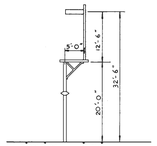
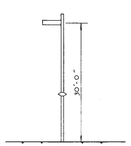


FIG. 5

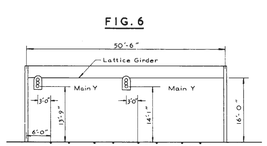


HARROW No.1
UP FAST OUTER HOME



HARROW No.1
UP FAST INNER HOME

FIG. 6



HARROW No.1
UP FAST DISTANT & UP SLOW DISTANT

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