MINISTRY OF TRANSPORT

Railway Accidents

REPORT ON THE COLLISION

between two passenger trains which occurred on 10th December, 1937, at CASTLECARY

on the

London and North Eastern Railway

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Report

by Lt.-Colonel A. H. L. Mount, C.B., C.B.E.
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LONDON AND NORTH EASTERN RAILWAY.

MINISTRY OF TRANSPORT,
Metropole Buildings,
Northumberland Avenue,
London, W.C.2.
24th April, 1938.

SIR,

I have the honour to report for the information of the Minister of Transport, in accordance with the Order of the 11th December, 1937, the result of my Inquiry into the circumstances of the serious accident which occurred at about 4.37½ p.m. on Friday, 10th December, at Castlecary, on the Edinburgh-Glasgow main line of the London and North Eastern Railway.

The 4.3 p.m. down express passenger train, Edinburgh to Glasgow, approached the station at 65 to 70 m.p.h., overran the home signal at danger, and collided at a speed of about 60 m.p.h. with the rear of the preceding 2.0 p.m. down express passenger train, Dundee to Glasgow; the latter was standing just beyond the platform, within station limits and in rear of the starting signal.

The Dundee train carried 10 first and about 100 third-class passengers; there were 23 first and some 175 third-class passengers in the Edinburgh train, which also carried a staff of 6 attendants for the dining car.

I regret to report that 34 passengers were killed instantaneously, and one succumbed next day in hospital; of this total, 8 first-class and 14 third-class passengers were in the Dundee train, and 13 third-class were in the Edinburgh train. They included a Company's Servant of each of the L. & N.E. and L.M.S. Railways.

Altogether 179 passengers were also injured or complained of shock, 24 and 155 in the Dundee and Edinburgh trains respectively. Of this total, 24 were detained at Infirmaries in Glasgow and Falkirk, all travelling third-class, three and 21 in the Dundee and Edinburgh trains respectively; nine others, third-class, were treated in Infirmaries and sent home, while the remaining 146 (of whom one and six were travelling first-class in the Dundee and Edinburgh trains respectively) were either treated at the time or reported subsequently that they had received minor injuries or were suffering from shock effects.

In addition, the driver of the Dundee train received severe injuries to his back, as the result of being thrown from the footplate. On the other hand, the driver and fireman of the Edinburgh train had remarkable escapes (referred to later); they merely received slight injuries and were shaken. The guard of the latter train also suffered severely from shock.

Briefly, the accident was brought about as follows:—The two trains were running eight minutes apart, the former two minutes late and the latter on time; snow was falling, however, and due to failure entirely to clear it from between the blades of certain facing points at Gartshore, 5¼ miles (three block sections) ahead, delay occurred from inability to move a lock-bar and to bolt the points concerned. This reacted on down traffic, and the Dundee express had therefore to be stopped at Castlecary to await the shunting of a goods train at the next box, Dullatur East; but the circumstances in which the express was brought to a stand—after passing the home signal at danger—appear to have misled the signalman, and the following Edinburgh express was improperly permitted to approach the station. Unfortunately, the Edinburgh express also overran the home signal at danger, as already stated, and the collision occurred 325 yards ahead of this signal, as shown on Drawing A.

The actions of the signalman at Castlecary and of the drivers of the two expresses are the principal issues in the case, while the weather conditions had an important bearing upon the circumstances of the accident.

II.—WEATHER CONDITIONS.

Attached as Appendix I is a Report by Dr. A. H. R. Goldie, Superintendent, Meteorological Office, Edinburgh, with regard to the meteorological conditions from the 6th to the 10th December inclusive at Abbotsinch (near Renfrew) and Stirling, 20 miles west-south-west and 9 miles north respectively of Castlecary. The change in direction of the wind was gradual; at midday on the 10th, it was south-east at 10 to 12 m.p.h., while at 5.0 p.m. there were gusts up to 20 m.p.h.,

from east-north-east, and shortly after this it was north-east. With east wind, Dr. Goldie considered that temperature at Castlecary might be one or two degrees lower than at Abbotsinch, their levels above sea being about 200 ft. and 19 ft. respectively.

Dr. Goldie's Report also refers to conditions at Leuchars Aerodrome (Fife), 50 miles north-east of Castlecary, while in respect of Haddington, 50 miles east, where an accident occurred at 10.45 a.m. on the 10th December, the Company's Report states that "*there had been heavy snow in the morning, followed by hard frost, and there was a slight drizzle of sleet at the time*". Another record is attached as Appendix II and relates to conditions at Springburn Public Park, Glasgow, 14 miles west-south-west of Castlecary.

The Reports, together with pen thermograms from Abbotsinch supplied by Dr. Goldie, indicate that maximum temperature there on the 6th December was 38°F. from about 11.15 a.m. to 3.45 p.m., when it commenced to fall to 28°F. or less, the minimum being 24°F., between 11.30 p.m. on the 6th December and 2.45 a.m. on the 7th, during which time, as will be related, a Signal Fitter was called to Castlecary to attend to a complaint that the down distant signal could not be lowered, owing, he assumed after his inspection, to a frozen wheel.

With regard to the temperature at Abbotsinch on the 10th December, a minimum of 20°F. was reached apparently about 1.0 a.m., after which there was a steady rise to 28° or 29°F. at about 7.0 a.m. The rise continued to 32°F. at 10.0 a.m., about which time snow commenced to fall, and to 32·8°F. at 4.0 p.m., after which the snow changed to sleet at 5.0 p.m., and to slight rain at 5.50 p.m.; at this time the dry bulb registered 31·1°F. and the wet bulb 32·8°F., snow then being three inches deep. Temperature thereafter remained approximately constant at freezing point till about 2.0 a.m on the 11th, rising to 36°F. at 7.0 a.m.

Having regard to Dr. Goldie's opinion that the fall of snow may have continued rather later at Castlecary, it appears that three inches is also a fair estimate of its depth there, and this is confirmed by a photograph which was taken from the west end of the up platform; it was early enough to include the rear coach of the Edinburgh train, a stretcher-bearer party traversing points No. 2, and, most important of all, the face of shunt signal No. 3, and its counterbalance weight covered with snow, as also the head of the rails of the up line.

It will be noted that visibility at Abbotsinch was frequently reduced to 500 yards during the afternoon, and that it decreased to this distance at about 3.0 p.m. at Leuchars, where heavy snow also fell between 2.0 p.m. and 3.0 p.m., moderating from 3.0 p.m. to 4.45 p.m., then changing to heavy sleet. At Stirling, there was 4½ inches of snow at 4.30 p.m. The wind was in the direction of travel of down trains when approaching and passing Castlecary.

With regard to actual conditions of visibility at Castlecary about the time of the accident, 34 witnesses gave their various impressions, and the question is dealt with in detail later. The majority, including the signalman, station-master, and train staff concerned, agreed that snow was falling, though less heavily than earlier in the afternoon; but the fog object does not appear to have been obscured, viz., the up home signal, 312 yards to the west of the box.

The moon was south-east by south of the signal box, and was in the first quarter, at an elevation of 30° from the horizon. It is very doubtful, however, whether it would have been visible; sunset was at 3.38 p.m., the mean of the relevant times for Glasgow and Edinburgh.

III.—Relief Work and Composition of Trains.

The attached Drawings A and B show the approximate site of the collision, the positions assumed by the two trains, the area over which the wreckage was thrown, and the location in which each fatally injured person was found, so far as could be ascertained.

Having regard to such trying weather conditions, the relief work appears to have been efficiently carried out. It was fortunate that the restaurant car on the Edinburgh train, and its six attendants, were available for service in this respect; a doctor on each train was also immediately available, and it was found possible to bring four of the ambulance equipments into use, namely, those in the brake vans of the first and fourth vehicles of the Dundee train and of the third and last vehicles of the Edinburgh train.

The stationmaster was present when the collision occurred, and steps were promptly taken to call assistance from Edinburgh and Glasgow and to advise all the Company's officers concerned. The third doctor arrived from Denny-loanhead at 5.0 p.m., followed by four from Falkirk Infirmary at 5.5 p.m., by six between 5.10 p.m. and 5.30 p.m., and by 12 at about 5.45 p.m. from the Western and Royal Infirmaries, Glasgow, accompanied by six nurses from the latter Infirmary. Two other doctors also arrived at 5.50 p.m. and 6.20 p.m. Altogether 28 doctors were in attendance.

With regard to Ambulance Staff, 40 trained men were present and 13 ambulances. A railwayman from Greenhill Junction arrived at about 5.30 p.m.; 22 men from St. Andrews Ambulance Association, Glasgow, arrived between 5.40 p.m. and 6.0 p.m. (accompanied by another doctor), while six railwaymen from Grahamston and Grangemouth arrived at 5.55 p.m., and 11 from Queen Street, Glasgow, at 6.57 p.m. The ambulances, which came from Falkirk, Larbert, Glasgow, and Grangemouth, arrived between 5.5 p.m. and 5.55 p.m.

Valuable assistance was thus rendered by the St. Andrews Ambulance Association, Glasgow, in services and in relief organisation, while the Chief Constable, Glasgow, was able to help materially by means of his police radio equipment. The Chief Constable of Dumbarton and the Procurator Fiscal of Dunbartonshire were also in attendance throughout the night and helped to direct the relief work, which was also immediately assisted by miners and other workers from Castlecary Fireclay Works and by residents in the village.

The Dundee express was hauled by engine No. 9896, "Dandie Dinmont," Class D.29, type 4-4-0 with a six-wheeled tender, weighing in working order 99 tons 7 cwts., length overall being 56 ft. 3 ins. The train comprised seven eight-wheeled bogie vehicles, with a six-wheeled fish van in rear, tare weight being 238 tons 16 cwts., and length overall 467 ft. 5 ins. The engine was fitted with the steam brake, vacuum controlled, operating blocks on the coupled and tender wheels, and on all wheels of the train, except the centre pair of the fish van; the percentage of brake power (270 tons) to total weight (tare) was 80 per cent. The total weight, including load, was some 350 tons. The marshalling of the train and particulars of construction are given in Appendix III.

The Edinburgh express was hauled by engine No. 2744, "Grand Parade," Class A.3, type 4-6-2 with an eight-wheeled tender, length overall being 70 ft. 5ins. It weighed in working order 152½ tons, and was fitted with the vacuum brake operating blocks on the coupled and tender wheels and on all wheels of the train, which comprised nine eight-wheeled bogie vehicles, weighing 301½ tons, length 564 ft. 6ins. The proportion of brake power (339 tons) to the total tare weight was 75 per cent. The total weight of the train, including load, was about 470 tons, and its overall length 635 ft. The marshalling of the train and particulars of construction are given in Appendix IV.

All the bogie carriages had heavy steel underframes of modern construction (except the second and fifth of the Dundee train) and teak wood bodies; they were fitted with Pullman vestibules, Buckeye couplers, and electric lighting throughout. Screw couplings were in use between the engine and the leading coach of each train, and the fish van was so coupled.

IV.—Effects of the Collision, Damage, etc.

The effects of the collision were quite exceptional; but, not receiving advice the same evening, I was unable to reach the site until Sunday morning, the 12th, some 24 hours later than I would have wished. The Company's officers, however, have taken much trouble to identify the wreckage, to ascertain how damage was caused, and to check with photographs the positions assumed by the vehicles.

The Dundee train had been stationary for about 7½ minutes, and probably the brakes were fully released; the engine and five leading vehicles were pushed forward some 52 yards. The fish van and the seventh and sixth coaches were destroyed, practically beyond recognition, while the fifth coach lost its rear bogie and was very badly damaged, its body in rear being smashed in by the mass of wreckage of the sixth.

The engine of the Edinburgh train came to rest 96 yards beyond the point of collision, and some 70 yards of track were destroyed. The engine became

derailed and was embedded in the cutting side, parallel with the track, and alongside the crumpled underframe of the sixth vehicle of the Dundee train. It was leaning over at an angle of 60 degrees from the vertical, but the tender remained in line and upright.

Such destruction, however, at the rear of the Dundee train, and the derailment of the engine of the Edinburgh train, were not sufficient to absorb the momentum of the latter, perhaps 54,000 ft. tons, and, as a result, the underframes and bodies of the first and second coaches literally overrode the tender and engine, and assumed upright positions ahead of it, as shown on the drawings; these coaches were followed by the third which came to rest, 12 ft. in the air, on top of, and hiding, the tender and engine. The bogies belonging to these three coaches were left behind in a pile, in rear of, and alongside, the tender, and acted more or less as a ramp which facilitated the overriding movement; the positions assumed by the five bogies of the fifth, sixth, and seventh coaches of the Dundee train are also shown on Drawing B.

No-one could have remained alive in the sixth and seventh coaches of the Dundee train. These vehicles acted as a cushion, and their bodies were simply obliterated; they were both modern, built in 1936 and 1935 respectively. One end of the underframe of the seventh was turned completely round so that the two ends were adjacent to one another, and it was carried forward in front of the engine. The underframe of the sixth, found alongside and to the right of the engine, was not quite so distorted; but many feet at the rear end had been twisted and buckled back in an extraordinary manner by the blow transmitted by the seventh underframe, which overtook it to the left and was carried forward, as already stated. The debris of the sixth coach had in turn smashed in the rear of the fifth (built 1906), which, however, was pushed forward with the train (coupled up, though minus the rear bogie), the intervening space of some 45 ft. becoming occupied by the first two coaches of the Edinburgh train.

It was thus considered that nine and eight passengers respectively were killed in the sixth and seventh coaches of the Dundee train, while five (including one who died in hospital) succumbed in the rear of the fifth coach. It was also thought that the 13 passengers who were killed in the Edinburgh train were all riding in the two leading coaches—six in the first and seven in the second—the underframes and bodies of which were thrown over the engine. Some 12 ft. 4 ins. of the underframe at the leading end of the first coach (built 1936) was completely buckled under, and the body (except the roof) was smashed; anyone killed here was apparently thrown out while this coach passed over the engine. The body of the second vehicle (built 1907), however, was much more damaged than the first, and both had to be subsequently burned.

The third vehicle (built 1936) of the Edinburgh train, a brake third with the brake compartment leading, was badly smashed at the front end, one side of the brake compartment having fallen outwards and the roof inwards; the underframe was also buckled downwards about midway, as it came to rest on the engine, but the passenger-carrying portion in rear was more or less intact, and from the photographs it appears that no windows were broken. This coach had to be rolled over on to the track before the engine could be lifted, and was also subsequently burned.

The fourth coach (built 1935) of the Edinburgh train was upright and had followed the third in line, but rose at an angle of about 15 degrees, the leading end in the air on the pile of bogies, and the trailing end on the ground, the track having been swept away; its windows were intact. The swivelling pin of the leading Buckeye coupler was fractured and the trailing coupler was so jammed that it had to be burned off; both Pullman vestibules were also damaged.

The fifth coach (built 1934) was also derailed, but remained upright and coupled, with windows intact; both Buckeye couplers were bent and had to be burned off, and the Pullman vestibules were slightly damaged. The remaining four coaches, however, were little affected (only the leading bogie of the sixth was derailed) and the last three remained on the road; the couplers were not damaged, and the shock to passengers in these vehicles was not severe. Indeed, certain people in the last coach stepped out on to the platform, and left the station to catch a bus, thinking that the train had come to a stand as the result merely of derailment of the engine; one lady wrote saying "*I did not suffer from shock at all, as it only seemed to me as if the train had been pulled up badly.*"

Statements regarding the conditions of the Buckeye couplers and Pullman vestibules on both trains are given in Appendix V. There was no telescoping in the accepted sense of the word. All the coaches had heavy steel underframes, except the second and fifth of the Dundee train, which had composite underframes (with wooden headstocks, longitudinals, and diagonals at the end sections), and it will be noted (particularly with regard to No. 31061) that, in consequence, more damage resulted. This also was the case with the second coach of the Edinburgh train, which was 30 years old.

With regard to the engine of the Edinburgh train, the bogie broke away, was wrecked, and was found under the trailing coupled wheels; both axles were bent and one wheel had been torn off by pressure which could not have been less than 80 tons. The buffer beam was badly distorted, and the chimney and smokebox door were broken off. Otherwise the boiler suffered comparatively little damage, and the cab was only slightly distorted, which, with the existence of the solid front to the tender, saved the lives of Driver D. Anderson and Fireman W. Kinnear, the coal having been prevented from enveloping them. Indeed, the former was not injured, while some acid from the battery of the third coach above them fell on, and burnt, the latter's cheek, and he received slight wrist injury. The cast-steel dragbox in front of the tender also helped to withstand the shock, this heavy casting having been pulled, or broken, in half. The back of the tender was also very badly damaged by the overriding coaches.

As already mentioned, the leading end of the underframe of the first coach, which consisted of six members (two solebars 10 ins. by 3½ ins. bulb angles, stiffened by 9 ins. by 3½ ins. angles, two diagonals 9 ins. by 3½ ins. angles, and two longitudinals 10 ins. by 3½ ins. angles) was completely lapped back flat for a length of about 12 ft. 4 ins. under the carriage, the front part of the body being shattered in the process. This extraordinary bending took place between the bolster crossbars and the first transom, as this portion of the frame is naturally weaker in compression than that between the bolster crossbars and the headstocks; the screw coupling must have held sufficiently long to have brought about this bend when the front of the coach rose over the top of the tender.

While six coach bodies in all, and that of the fish van, were burned in clearing the wreckage, no fire resulted from the collision; the Falkirk Fire Brigade put out the engine fire about midnight. The lines were not opened again until 1.30 a.m. on Monday, 13th December, traffic between Glasgow and Edinburgh having been diverted via Bathgate.

V.—Description.

As shown on Drawing A, the Company's main line at Castlecary lies in an east (Greenhill Junction, Falkirk, Polmont, and Edinburgh) and west (Dullatur East, Croy, Gartshore, and Glasgow) direction; the site of the collision, 33 yards beyond the west end of the station platform, was in cutting, some 20 ft. deep.

In the down direction from Edinburgh, the station is approached over practically level gradient for a mile on straight alignment, up to the west end of Castlecary Viaduct, near which the down home signal and the signal box are situated; thence the line curves to the right through the station on a radius of 106 chs., the site of the collision being 294 yards west of the box.

The signalman, when standing at his frame, could not see the tail lamp of the Dundee train in this position, as the corner of the goods shed intervened; for this and traffic reasons in connection with shunting operations, a track circuit was provided in 1921 from a point 18 yards ahead of the down starter, through the platform, back to the points of the connection near the footbridge, 112 yards from the box. On the other hand, by moving to the window at the front of the box, on either side of the frame, the signalman can retain vision of a tail lamp throughout its passage round the curve.

Otherwise, an excellent view is obtained from the box, the floor of which is 8 ft. 10 ins. above rail level; besides the windows along the front, one of which at each end is capable of being opened, there are windows on both sides. The frame faces the line and contains 17 working levers with one spare. There is no record with regard to the date of the box and frame.

Drawing C illustrates the shelf immediately above the levers, there being the usual three-position block instruments, of pegging needle type, with switching-out equipment on the right-hand side; in the centre, between the block instruments, there is the indicator of the track circuit referred to above,

the only one in the station. A repeater of the arm of the up distant signal was located at the west end of the shelf, but the down distant was not repeated, neither arm nor light, as the signal was within view in clear weather. The door of the box is at the back of the west wall, the fire in the centre of the south wall, the telephones and desk on the east side of the latter, and the clock on the wall above. The hand signal lamp was kept—apparently to avoid smell—on the ledge outside the front window at the east end.

The signals concerned, the down distant, the home, and starter, are 777, 31 (East) and 450 (West) yards respectively from the box, of lower quadrant type, and 39 ft. 3 ins., 29 ft. and 49 ft. 4 ins. in height above rail level. The down distant signal comes into view with an excellent sky background after passing an overbridge, 943 yards in rear of the signal; when necessary, under conditions of bad visibility, drivers use this overbridge to locate themselves. The down home signal has a background of trees until the viaduct is reached, when the arm can also be seen against the sky.

At the time when the Dundee and Edinburgh trains approached, the fading light of sunset was directly behind the signals, while the moon, as already mentioned, was in first quarter; it is doubtful, however, whether these two conditions were of material assistance in respect of the view obtained by the two drivers concerned, having regard to the reduced range of visibility due to the falling snow, which will be referred to later.

There is no record as to when the distant signal was installed; but all moving parts on the post were completely renewed in February, 1929, and the vertical $\frac{3}{8}$ in. rod was again renewed in November, 1931, owing to breakage at a weld. The post was of lattice type, 9 ft. 4 ins. from the centre of the track, and located on bank about 30 ft. in height.

The wire adjusting apparatus in the box, as shown on Drawing D, was of the usual type, and provided for a direct pull up and down, the handle being secured by a pin; with 2 ft. $2\frac{1}{2}$ ins. leverage on the tail of the signal lever, a pull of about 85 lbs. by the signalman produced a pull of 232 lbs. on the chain below the frame (tested by spring balance on the 9th February, 1938), which was sufficient to move the signal from the *Caution* to the *Clear* position. Other spring balance tests at the post itself showed that it took 155 lbs. to move the signal from *Caution* to *Clear,* and 135 lbs. to hold it in the latter position; from the above figures of this particular test, it is clear that 77 lbs. was required to take up slack in the wire and to overcome friction, while after the lever was returned to normal in the frame the force at the post which was available to return the arm to normal was 135 lbs. minus 77 lbs. = 58 lbs.

The original travel of the wire at the box was 8 ins., and, by virtue of the draught wheel, this is increased to 16 ins. between the box and the first flat leading-off wheel outside. The latter wheel was uncovered, 10 ins. in diameter, and situated about 17 ft. in front of the box, between the siding and the down main line; a chain passed round it, thus connecting up with the wire which led across the viaduct to the distant signal by a straight run on posts spaced 10 yards apart and some 20 ins. above the cess. Between the chain on the flat wheel and the chain round the wheels in the cabin, there was also a length of 14 ft. 9 ins. of wire passing under the siding; this piece of wire had been renewed and lengthened on the 24th November, to provide greater facility for adjustment as the nights were getting colder.

The whole run of wire to this signal had been renewed in August, 1936; it was of the Company's standard seven-strand type, weighing 1 cwt. per 400 yards. Careful consideration, and tests which have been carried out upon this wire, indicate that the co-efficient was ·000008, and that therefore expansion or contraction, for the whole run of wire, may be estimated at 4·43 ins. over a range of temperature of 20° F. The travel of the wire at the signal, to cause movement of the arm from horizontal to fully clear, was $4\frac{1}{8}$ ins., and, compared with the travel of 16 ins. outside the signal box, this leaves $11\frac{7}{8}$ ins. slack.

There was no record of any renewal of chains or of the flat leading-off wheel, such work, if carried out, being day-to-day maintenance and not specially noted. The lineman concerned had no recollection of any such renewals since 1928, and all the equipment, including the leading-off wheel, when examined after the accident, appeared to be in good order and well maintained.

The adjustment of the signal itself, however, was found to be abnormal, in that the arm could *droop*—if circumstances so permitted—by as much as

14½ ins., viz., to an angle of 16°, before the backlight blinder reached the bottom of the backlight bullseye. In other words, when the signalman relied on view of the backlight, after dark, to assure himself that the signal was at *Caution*, it might, if *drooping* from any cause, have been able to assume an angle of 16° from the horizontal, while the full backlight was still displayed, and the light could not be completely obscured unless *droop* became as much as 29½°. The *full-off* position of the signal was 48½°.

The signal lamp concerned was of the long-burning pencil flame type, which, though no longer being installed to-day for reasons, I understand, other than inefficiency in power of illumination, appears to have been in good order and was alight after the accident. The arrangement for trimming the lamps at Castlecary is that one of the three signalmen deals with them between 10.0 a.m. and 2.0 p.m. every Saturday; the accident therefore occurred on the day before the lamps were due to be trimmed, but this does not appear to have had any bearing on the circumstances.

The track circuit, already referred to, was indicated in the box by a banner type instrument (*vide* Drawing A) showing *Clear* or *Occupied*, and, in addition, when the line in rear of the down starting signal was occupied, an electric lock was applied to the down home signal lever in its normal position. The track circuit battery consisted of 2/220 A.D. cells, connected in parallel and located near the down starting signal; the battery fed the track through an adjustable resistance, and it was connected to the rails by means of two single core 7/·029 conductors, lead covered, armoured, and served over-all with jute. The relay was located at the entering end of the circuit, and was connected to the rails in a similar manner. The battery for energising the lock on the down home signal lever and for operating the indicator to the *Clear* position—they were connected in parallel—consisted of dry cells, fixed in the same cupboard as the relay, and led through the relay front contacts to the line circuit, which consisted of 150 lbs. covered insulated wire. The rail joints were double bonded with 400 lbs. G.I. wire.

VI.—Report.

1. The evidence was very contradictory, but the following account briefly describes the circumstances in which the accident occurred, and there was no material discrepancy in the times recorded in the boxes concerned.

The delay, already referred to, was brought about by the insufficient clearing of snow from the points of a facing connection leading into the down loop at Gartshore; the two lengthmen concerned had little experience in such work where lockbars are fitted, and do not appear to have appreciated what a small amount of snow would prevent the point blade closing to the extent necessary to allow the bolt to enter the stretcher bar. The signalman, though he himself made an unavailing attempt on the ground, was thus prevented for about half-an-hour, until the arrival at 4.30 p.m. of Signal Lineman Wilson, from pulling the lockbar lever and bolting the facing points in question (after a mineral train had entered the down loop) to permit of continuance of down traffic on the main line.

In consequence, the 3.41 p.m. passenger train, Polmont to Glasgow, which had stopped at Castlecary at 3.59 p.m., had to be held up at Croy from 4.9 p.m. till 4.37 p.m. The following 2.50 p.m. Falkirk to Cadder goods train, which had passed Castlecary at 4.9 p.m., was therefore stopped at the home signal at Dullatur East at about 4.15 p.m., and, according to the evidence, Signalman Andrew Sneddon of Castlecary was aware of this. The latter train could not be shunted at Dullatur East, to clear the down line for the following expresses, as was the intention, until the passage of two up passenger trains (4.0 p.m. and 4.6 p.m. ex Glasgow) at 4.23 p.m. and 4.31 p.m. respectively.

2. Signalman Sneddon accepted the Dundee express from Signalman G. Beattie of Greenhill Junction, at 4.22 p.m., and the train entered the section at Greenhill Junction at 4.28 p.m.; when, however, it was within near approach of Castlecary, Sneddon, according to his account, realised, by the view which he had of the engine continuing to steam, that the train would fail to obey the home signal which was at danger. He had time to display a hand signal lamp showing red from the east end window, outside which the lamp stands, as already mentioned, and he used his railway whistle to attract attention.

The train appears to have approached the distant signal at 50 to 55 m.p.h., and Driver D. Macaulay stated that the arm "*was standing clear for me. I have no doubt about that whatever*"; but he missed the home signal. However, he observed the red hand signal from the box and made a rapid brake application, bringing the train to a stand, according to his report of the 11th December, "*AT the advance signal which was standing at danger*", viz., with the rear of the tender roughly level with the signal. The footplate and the tail lamp were therefore some 458 yards and 294 yards respectively from the box.

Fireman Fleming had not observed any signals after leaving Falkirk, as he was in some difficulty with his fire, being short of steam (150 lbs.) and low in water. The record of the running of the train confirms this; having left Falkirk (distant eight miles) at right time, 4.20 p.m., Bonnybridge was passed 2 minutes late and Greenhill Junction $1\frac{3}{4}$ minutes late, while the scheduled time of passing Castlecary was 4.28 p.m.

On the train passing the box a little before 4.30 p.m., Macaulay did not whistle, and, as Sneddon observed no signs that the train was stopping, he stated that he assumed it had entered the section; he therefore transmitted the *Vehicles-Running-Away-On-Right-Line* signal to Signalman Smith at Dullatur East, imagining, according to his statement, that a collision with the waiting goods train ahead might take place within a couple of minutes.

Sneddon's evidence, however, was that, even while transmitting the long bell signal, 4-5-5, he did not observe the track circuit indicator which was immediately in front of him; nor did he return to the front window to confirm his assumption that the train had passed into the section. Hence his failure to realise that the train had come to a stand on the track circuited portion of line in rear of the starting signal, and to observe the stationary tail light (on the cess side) of the fish van, 294 yards from the box, viz., on the east side of the up home signal (the fog object, 312 yards from the box).

The engine thus came to a stand at about 4.30 p.m., and still Driver Macaulay did not whistle. But Fireman Fleming, having been told by Macaulay that he had missed seeing the home signal, went back as quickly as he could to the box, after speaking to Guard T. Inglis who was riding in the fourth vehicle; both confirmed Macaulay's statement that the train remained in the position in which it came to a stand.

3. After sending the *Vehicles-Running-Away* signal, Sneddon appears to have telephoned without delay to Probationary Clerk D. Macdougall in the booking office, sending for Stationmaster W. Scott, who was then returning from the neighbouring brickworks; the latter alleged that, before reaching the booking office, from a position near the footbridge at the east end of the platform, he "*could see the tail lamp quite plainly*", at a range of only 175 yards, "*just beyond the starting signal*", which was actually distant no less than 330 yards, and he "*had no difficulty in seeing the arm of the down starting signal, although there was slight snow just at this time*". He also alleged that even after speaking to Signalman Sneddon on the telephone, he did not know until he reached the box (4.35 p.m. or 4.36 p.m.) that it was the Dundee express which had come to a stand after passing the home signal at *Danger*. Macdougall confirmed this, and he also appears to have formed the impression that the tail light, which he observed (at a distance of 145 yards) from the platform opposite the box, "*was a long way off*" and beyond the starting signal, distant 300 yards.

4. Sneddon's account was that, after sending for Scott, instead of ascertaining from Smith at Dullatur what had happened to the Dundee express, which he anticipated would be involved in collision there, he telephoned to Beattie at Greenhill Junction with regard to accepting the Edinburgh express; he advised Beattie that the Dundee train had passed the home signal at *Danger*, that "*I had seen the tail lamp, and my track was clear*", and that the *Vehicles-Running-Away-on-Right-Line* signal had been sent to Dullatur East. Sneddon explained that he was "*doubtful whether this entitled me to accept the 4.3 p.m. Edinburgh train, and asked his opinion on the matter*". Sneddon affirmed that while he was speaking to Beattie, he noted that the track circuit indicator was clear, and his evidence was that "*I am positive about this, because I certainly would not have told Beattie, when explaining the position to him, that the track was clear without first observing the position of the indicator*".

Signalman Beattie confirmed this conversation, and the following is an extract of his evidence:—

> " On asking what was wrong, I was told the 2.58 Falkirk High and Cadder was ahead standing at Dullatur East. I asked, ' Have you sent the Vehicles-Running-Away-On-Right-Line signal? ' He said, ' I have done so.' I also asked if he had put down detonators. He said, ' No.' ' You should,' I replied. He asked why, and I said, ' It is always a precaution.' This conversation took place at about 4.31. About a minute or two after he rang me again and asked, ' Am I justified in clearing back the Dundee and taking on the 4.3? ' I replied, ' There is nothing to hinder you provided you saw the tail light and the regulations applied.' I asked, ' Are you certain all your signals are at danger? ' He said, ' Undoubtedly.' I then asked, ' Have you got your quarter mile clear ahead of your home signal? Are you certain of that? ' He replied, ' Yes.' I then said, ' There is nothing to prevent your accepting the 4.3.' He then left the 'phone, cleared back the 2 o'clock ex Dundee, and accepted the 4.3 ex Edinburgh at 4.32. ' Train-Entering-Station ' was sent by me at 4.36 . . . . "

5. Fireman Fleming reached the box shortly after 4.35 p.m. at which time he signed the train register; but his entry had been tampered with, an unexplained and most unsatisfactory feature. Scott immediately followed Fleming into the box, by which time Sneddon realised, with an expression of relief (according to Fleming) that the Dundee train had stopped. Fleming's account, however, indicates that Sneddon—in then speaking on the telephone to Signalman D. Smith of Dullatur East—was still under a misapprehension with regard to the position of the train, as he told Smith that it had stopped in the section, and Fleming had to correct him.

Fleming's evidence is that Sneddon then said *" I'll have to see about getting the 4 o'clock stopped "*, when Fleming remarked that *" it was time there were detonators on the track "*. Scott's account was that he looked out of the window and saw the tail lamp of the Dundee train (294 yards away), showing only a faint light, as the result of reduced visibility owing to the falling snow; he added that *" then the signalman told me ' That's the Train-Entering-Section signal for the 4.3 passing Greenhill', and I ran for the detonators "*.

Sneddon was followed by the two men from the box, but time was so short that he alone was able to lay three detonators, only one of which was properly fixed and subsequently exploded—he could not say on which rail—between the home signal and the west abutment of the viaduct; he also displayed his red lamp.

6. The 4.3 p.m. express left Edinburgh on time, and was due in Glasgow at 5.1 p.m., viz. a schedule of 58 minutes for 47¼ miles, start to stop, three minutes having been added in May last for a speed restriction of 15 m.p.h. at Dullatur. The 31¾ miles to Castlecary were covered in 34½ minutes; Bathgate Junction was passed one minute late and Polmont Junction 1½ minutes late. Thence the seven miles 57 chains to Greenhill Junction were covered in about 6½ minutes, according to the bookings, as compared with the schedule of 7½ minutes. This represents a speed of about 70 m.p.h., and it seems unlikely, therefore, that Castlecary down distant signal was passed at less than 65 m.p.h.

According to Driver D. Anderson's evidence, the signal was in the fully *clear* position. He did not, however, think that he was exceeding normal speed which he judged was about 60 m.p.h., and he said that the falling snow prevented him from viewing the arm—through the left side cab extension glass screen, which he was wiping continually—at more than 50 to 100 yards. *" I was practically on top of it before I saw it "*, and he said he also turned and viewed it over his shoulder by the light of the fire. He could not see the light, owing, he thought, to the spectacle being covered by snow, as was the arm. He passed the home signal at about the same speed, but he did not see it; however, he said he observed Sneddon's red lamp *" held steady "*, passed the remark that *" this is something unusual "*, and was in the act of applying the brake when he heard one detonator explode. He closed the regulator and opened the sanders, but had no time to move the reversing gear, which was subsequently found in fore-gear notched up to 25 per cent. cut-off. He saw the tail lamp ahead on approaching the end of the platform, and shouted to Fireman Kinnear to hold on.

I conclude that Anderson did not make his brake application until passing the box (and due to brain lag it may have been later still), viz. 294 yards before reaching the obstruction. From subsequent tests which have been carried out with a similar train, it appears that the vacuum in the rear van could not have

decreased much below 10 ins. after 10 seconds, when the collision occurred at, say, 60 m.p.h.; in fact, the brakes could hardly have been felt in the rear of the train.

Kinnear generally confirmed Anderson's evidence; he was observing as many signals as he could, but not all. The last distant signal which he observed (from the right-hand side of the footplate) was that of Greenhill Junction, at a range, according to his estimate, of not more than about 30 yards; he then fired, and after that "*there were one or two large pieces of coal coming down, and I was breaking them, and by the time I got the coal broken and got a fire put in, we must have been past the distant signal*", which he therefore failed to see. He also missed the home signal, as he was engaged in sweeping up the footplate; but he heard the detonator. He knew the road well and the landmarks, and was having no trouble with the engine.

7. On return to the box, Stationmaster Scott and Signalman Sneddon were concerned with questions of blocking the line, advising Control, telephoning for relief, etc.; according to their evidence, neither of them tried to look at, or even to consider, the positions of signals, nor did they touch the equipment, and so far as Scott was concerned, he evidently assumed that the distant signal was at *Caution*, as the lever was normal, like the others. Indeed, the home signal lever was locked normal by the occupation of the track circuit, the indicator of which was then showing *Occupied*.

VII.—Evidence with regard to Visibility, etc.

1. Ganger T. Bell, accompanied by the four undermentioned lengthmen, left Greenhill Junction at about 3.15 p.m., walked down the line, and reached Castlecary at about 3.50 p.m. Though Bell said that no trains overtook him during this time, the records show that two certainly did and possibly a third, and generally I do not attach much importance to his evidence. He said it was snowing, but visibility was fairly good, viz., "*a little more than ¼-mile or thereabouts*", from which distance he viewed the down distant signal at *Caution*, and reached it at about 3.35 p.m. He could not say, however, that he paid particular attention to it, and thought there was very little snow on the arm and spectacle; the condition of the arm of the home and its visibility were much the same.

According to Bell, the direction of the wind was from the north, and there was little difference between the amount of snow on the arms of the up signals and that on the down signals. He said it began to fall at 1.0 p.m., and thought it "*slackened off considerably*" between 4.0 p.m. and 4.30 p.m., when the men left duty, just before the Dundee express arrived; they spent the intervening time cleaning points in the yard, and point rodding, signal wires, wheels, etc., leading from the box. He had no reason to suppose that the down distant signal equipment was not working properly, and he did not touch its wire as he walked along the line; there was no sign of obstruction, and the wire was generally 20 ins. above cess level. Lengthman H. Harrison confirmed Bell's evidence, and also failed to remember any trains overtaking him.

On the other hand, Lookout-man Aitken stated that it was not snowing at the time; indeed, it had stopped "*shortly after three*", and had not recommenced before he left duty at 4.30 p.m. As regards his range of view of the down distant signal, he estimated it as "*about half a mile*", and said he could see it from the overbridge, viz., 943 yards; there was very little snow on the arm and the spectacle. Fearns agreed with Aitken that the distant signal could be viewed at *Caution* at a range of half-a-mile, but he admitted that snow was falling, though "*it was slackening a little. It was not very heavy*". Again, Lengthman J. McQuillan could not remember the position of the distant signal arm when he passed it; but he estimated visibility as ¼-mile, agreed that it was "*snowing very little*" when he left Greenhill Junction, and thought it had stopped by the time he reached Castlecary.

Lengthman A. McDonald (only two months' experience) arrived from Greenhill Junction by motor bicycle at about 3.40 p.m., to await the arrival of Bell and the gang. He said that it was dull, but not snowing then; "*the roads were covered with ice*". On arrival, Signalman Sneddon had asked him to shake the snow from the up home signal. He said that it started to snow again "*maybe a little after 4 o'clock*", and when he left the station later, presumably just before the accident, the snowflakes were large. His estimate of visibility, however, was vague, due to lack of knowledge.

Signal-Fitter R. Wilson gave a different account. He travelled on the footplate of the engine (chimney first) of No. 1446 special goods train, which left Greenhill Junction at 3.33 p.m., passed Castlecary at 3.41 p.m. (overtaking the lengthmen who were walking down the line), and arrived at Croy at 3.53 p.m., after which he was summoned at 4.0 p.m. to go to Gartshore to deal with the lock-bar already mentioned. Wilson said it snowed heavily all the way, increasing, he thought, in density about Croy and Gartshore, where it was heaviest between 4.0 p.m. and 4.30 p.m., and particularly while he was dealing with the lock-bar at the latter time. During his journey to Croy, he was not looking out or paying particular attention, but he was of the opinion that vision was definitely restricted by the snow, and there was some on the signal arms and spectacles.

2. Driver J. Cairns, Fireman J. Miller, and Guard H. Stavert worked the following 3.41 p.m. down passenger train, Polmont to Glasgow, which stopped at Castlecary at 3.59 p.m. and was held up at Croy. Cairns said that it was snowing heavily all the way. It was darker at Castlecary than at Polmont; but the remaining daylight assisted him, and while the view of signal arms was not normal, he was able to see the Castlecary distant signal, in the *Clear* position, at a range of 300 to 400 yards, travelling at 30 to 35 m.p.h. He could not see through the front windows; he was looking over the cab side. While standing at Croy ($4\frac{1}{4}$ miles away) between 4.9 p.m. and 4.37 p.m. it snowed all the time, and "*piles of it*" blew on to the footplate. He stated very definitely that all down signal arms were covered with snow, and he did not think he saw any signal lights, except one. He is a man of long experience, a good witness, and said he could not recall a worse evening in this respect. He was unable to see the light of Castlecary down distant signal as he passed it. Fireman Miller confirmed the above, and added that while standing at Croy visibility was 150 to 200 yards, and he thought this represented conditions during the journey from Greenhill Junction.

Guard Stavert said it was snowing when he left Glasgow on the 2.30 p.m. train to Polmont, but he thought it was heavier on the return journey, though at stations Cairns was able to see his hand signals at a distance of about 100 yards. He looked out when passing Greenhill Junction and had difficulty in observing signals due to snow blowing in his face, but he did not look out at Castlecary. "*It was coming in fits. Sometimes it would be heavy and other times it would ease off a bit*".

Driver W. McDonald, Fireman C. Smith, and Guard P. Penny worked the Cadder goods train, which passed Castlecary at 4.9 p.m., and was at a stand at Dullatur East from 4.15 p.m. till 4.33 p.m. The engine was running tender first, and the train left Greenhill Junction at 4.1 p.m. McDonald said that it was snowing all the way, and heavier between Greenhill Junction and Dullatur East; all signals at Castlecary were clear, but only the arms, white with snow, were viewed at very close range; as also at Dullatur East. The lights were not visible. Fireman Smith confirmed the foregoing account; speed through Castlecary was about 25 m.p.h.

Guard Penny said that the train consisted of 35 loaded mineral wagons and one goods; between Falkirk High and Greenhill Junction he had a good view of all signal arms, and they were covered with snow. It was snowing heavily at Greenhill Junction, and thence the semaphores could only be seen at a range of about 200 yards, viz., after the engine had passed the signal. He distinctly remembered seeing all those at Castlecary, and he waved to Signalman Sneddon, who replied by waving a duster. He saw no light in the distant signal and only poor ones in the home and starter; "*there was heavy snow on the arms of the signals and also on the specs.*". The windows of his van were "*stuck up*" with snow, and, standing on the verandah which was at the rear end, he was looking out over the side. The snow had stopped when the train left Dullatur at 5.58 p.m., and visibility of signal lights improved to about 70 yards. Under considerable cross-examination, Penny was emphatic that the signal arms were entirely, and heavily, covered with snow, and that is why the lights could not be seen more easily.

3. Driver Macaulay, a man of long experience, who was in charge of the Dundee train, said that "*the weather was very bad and it was snowing when we left Thornton. . . . I was seeing the signals, but I could not exactly say at*

what range. The signals were not bad till we got on to the main Edinburgh-Glasgow line. . . . It was daylight till we got to about Falkirk. It was in the gloaming at Falkirk, and visibility was getting less and less as we went along. . . . The snow was very bad at Falkirk and Greenhill. The flakes were heavy. . . . The snow was striking it (the cab window) and melting on it, and you could not see anything".

Macaulay estimated that speed was about 50 m.p.h. when approaching Castlecary; he said he observed, over the cab side, the distant signal, in the clear position, at a range of 150 yards. He withdrew his head, wiped his face, and on passing over the viaduct looked out again for the home signal. *" I got halfway over the bridge when a red light appeared on the left-hand side of the line. . . . I did not see the light of the signal box at that time. . . . The signalman seemed to lift the lamp. The lamp moved. I thought that was for me. I just came inside and applied the brakes. My attention was attracted by the lamp, and I missed the home signal. . . . I assumed it would have been off with the position of the distant signal, but after the red lamp of the signal box I knew there was something wrong. . . . I came to a stand with the starting signal about the end of the tender".*

Fireman Fleming confirmed Macaulay's evidence with regard to the weather; *" it was snowing more or less all the way up to Castlecary, and I should say that visibility was poor".* As already stated, the last signal which he had observed was the Falkirk down distant, at a range of about 150 yards. He thought that speed was normal, and that Macaulay applied the brake before the engine passed the box. He said that Macaulay made no comment with regard to the difficulty of viewing signals, and it was only as the train was coming to a stand that he had said he missed the home signal.

Fleming was near the home signal when the Edinburgh express passed; he confirmed that it was snowing then, though *" it was not just so heavy at that time as it had been through the day",* but his first view of the train was certainly after it had passed the distant signal, and he could be no more definite as to the distance than in saying that *" he was nearhand when I saw him".*

Guard Inglis said that *" it was snowing when we left Falkirk (the last booked stop, 4.20 p.m.), but I think I am correct in stating that I could see ahead for a distance of 400 yards".* He was riding in the fourth vehicle and looked out at Castlecary when he felt the brake application, but it was after he had passed the box and the home signal; on the train coming to rest, he proceeded forward, descended to the ground from the front coach, and noted that the rear of the tender was approximately level with the down starter, which was at *Danger* and covered with snow. He could see the arm by the light of the train, and the red paint was obliterated. (Presumably the signal had not been moved for at least 20 minutes, since the passage of the Cadder goods train.) Inglis' impression of visibility was that *" the snow had practically ceased at that time, but we were in the cutting, as it were, and you could see nothing practically".*

4. Stationmaster Scott said that it was snowing slightly when he assumed duty at 8.0 a.m., but it was not *" very heavy at any time, except in the afternoon between 3 and 4 o'clock."* He went over to the brickworks shortly after 10.0 a.m., and again between 4.20 p.m. and 4.25 p.m. He said he had satisfied himself that fogmen were not required, but he judged that the fog object, the up home signal, was only 200 yds. from the box, while it is actually 312 yds. With regard to his range of vision, when the storm was at its worst, *" I couldn't just say, I could see quite a distance anyway."* He stated that at about 4.20 p.m. he received an assurance from Ganger Bell that all signals were working properly and were clear of snow, and when he went to the brickworks at that time *" it was snowing slightly, it was not heavy."* Lighting-up time on the roads was 4.11 p.m. An extract of his cross-examination is as follows:—

> When you went out then didn't you look at any of the signals?—Yes, I looked at all the signals.
>
> At that time you could see the down distant signal?—No, I did not look at the down distant signal.
>
> You have just said you looked at all of them?—Just the ones round the station I looked at.
>
> Did you look at the up starting signal?—Yes (70 yds.).
>
> And the up advanced starting signal?—Yes (540 yds.).
>
> Could you see its light or the arm?—I saw the arm. Of course, it was quite clear then.

It was the arm I saw. It was quite clear at 4.20.
Do you mean there was no snow?—No, but it was the visibility. It was daylight at 4.20.
And you could see the arm?—Yes.
But you did not see the arm then of the down distant signal?—No, I can't say I did.
It was right in your line of sight?—Yes, but I can't remember seeing it.
Did you look in the other direction? -Yes.
At the down starting signal?—Yes.
Could you see that then?—Yes.
Was this from opposite your booking office?—Yes, just outside the office.
That was at 4.20?—Yes.
Could you see the light of the down starter?—No.

With regard to what happened immediately after the Dundee train had come to a stand, Scott's evidence was that, on being called by Probationary Clerk Macdougall to return to the office (at 4.31 p.m. or 4.32 p.m.), he was able to see without difficulty the arm of the down starter, 330 yds. from the footbridge; but he could not see its light as it "*was only half dark at the time.*" According to his account, it was then that he formed the seriously erroneous impression, which was supported by Macdougall, that the tail light of the train, only 175 yds. away, was beyond the starter. Under this alleged impression, he followed Fireman Fleming into the box soon after 4.35 p.m., and his second view of the tail light of the train, at a range of 294 yds., was "*very faint, because of falling snow*"; he also suggested that the smoke from the 4.6 p.m. train ex Glasgow, which had passed between 4.32 p.m. and 4.33 p.m., had not cleared away.

Signalman Sneddon affirmed that, though the snow was blowing on to the east windows of his box, he saw the arm of the distant signal return to *Caution* at 4.9 p.m. when he operated the lever for the last time, after the passage of the Cadder goods train; also that he observed the backlight at 4.22 p.m., when he accepted the Dundee express and when "*it was slight snow at that time.*" Sneddon also stated that he observed the backlight when accepting the Edinburgh express at 4.32 p.m., but this is contradicted by the account of a conversation which District Inspector E. Cunningham had with him after the accident, at about 5.53 p.m., to the effect that Sneddon had said "*he had not noticed it*"; nor did Sneddon try to observe the signal after the accident.

Sneddon suggested that the worst of the storm was between 2.30 p.m. and 3.20 p.m., and, with regard to visibility, that "*it was snowing heavily, but I could see all my signals*"; in this connection he also stated that "*if I could not have seen the position of the distant signal, I would have got the train stopped at the cabin in rear and advised them to take that signal as defective . . . . I had a view of my back spec on my distant signal, and therefore it could not be hanging off.*" The signal was "*working perfectly.*" He was "*shaking the signals too,*" because "*it was one of the Rules that you must carry out*"; he said that the first signal usually affected by weight of snow was the up starter, and, as already mentioned, he drew Lengthman McDonald's attention to it.

In brief, Sneddon's account was that it was snowing heavily at about 3.0 p.m., and again just before 6.0 p.m.; but that "*there was abatement for at least 45 minutes before the accident,*" up to the time of which the distant signal arm, or its backlight, was visible to him. At 5.42 p.m. "*it was snowing heavier than ever,*" and therefore he did not think he could have seen the backlight at that time, though he did not try to look at it.

Signalman D. Smith of Dullatur East had arrived on duty at 2.0 p.m., and described the snow as intermittent. A little snow was adhering to his signal arms. His fog object, the up home signal, is 301 yds. from the box, and he estimated that he could see 50 yds. beyond it; visibility of lights was better in the up than the down direction, but generally he did not think range of view exceeded ¼-mile.

Signalman Beattie, with seven year's experience at Greenhill Junction, said that at about 4.30 p.m. "*there was practically no snow and the visibility from my box was quite good. Looking east, I could see about half a mile, but in the westerly direction I could only see my signal lights as far as the marking point which is the up home signal,*" 250 yds. away; he later suggested ¼-mile westwards. His reason was that the wind was driving the snow on to the signal spectacles, while the backlights (looking eastwards) were not thereby dimmed.

5. The evidence of the enginemen of the Edinburgh express with regard to visibility and speed of the train has already been mentioned. Anderson said it was not snowing when the train left Edinburgh, but it started at Ratho, and

visibility varied to Castlecary; *"I was seeing the arms of the signals in most places and sometimes the light . . . . Sometimes you could see them a good distance away and next time you were practically up against them before you saw them."* He defined a *"good distance away"* as *"maybe 150 yds., maybe 200 or 300,"* and *"up against them"* as a matter of 50 to 70 yds. He judged that visibility at Greenhill Junction was 300 to 400 yds; apparently he could remember observing lights of all the signals there, except one. (There are long-burning oil lamps in the down distant and down starter, but electric lamps in the outer and inner homes.)

Approaching Castlecary it was snowing *"fairly heavy"* and *"there was no moon. It was dark."* Anderson knew where he was, and after passing the overbridge, the regulator remaining open, he estimated, as previously stated, that he observed the distant signal arm *"distinctly"* and *"properly"* clear, at a range of 50 to 100 yds. He stated that he *"was looking in the air at the time, and I would not say for the actual distance,"* having regard to the height of the signal, and he looked back at it as he went by. He did not see the home signal because *"I observed the red lamp and changed my glance to the red lamp on the ground,"* the detonator exploding simultaneously. Kinnear's evidence with regard to the weather generally was that *"snow was falling all the time from leaving Edinburgh, and visibility was very poor."*

Guard Cameron looked out when passing Bathgate Junction (4.15 p.m.) and Polmont (4.30 p.m.); it was snowing at both places and he estimated that visibility at the latter (4½ miles east of Castlecary) was about ¼-mile, *"it was bad, very bad."* He did not look out again, but he estimated that speed through Greenhill Junction was normal, 60 m.p.h. At the time of the collision, he was seated in his van in the rear coach, and felt no previous brake application; he rose to apply the brake and was thrown along the van on to mailbags. He looked at his watch immediately, then 4.36½ p.m.; but comparison of his journal with signal box timings suggests that the watch was a minute slow, though Cameron stated that he had checked it on leaving Edinburgh. He stepped from his van at once on to the platform (west end); *"it was snowing very slightly."* But he did not think he could have seen as far as the down starter (206 yds.); *"it was very misty, hazy."* He did not try to observe the backlight of the down distant, and, of course, did not think of judging range of visibility. He went back, however, and laid detonators at the west end of the viaduct, from which point he could distinctly see the tail light of his train, distant about 275 yds. Generally, he did not think he could then have seen signal lights at a range of ¼-mile, and certainly not at ½-mile.

Mr. G. S. Inglis, the Company's District Engineer at Carlisle, was a passenger in the restaurant car, the sixth vehicle, and was not injured. His impression was that speed immediately before the collision was *"something over 60 m.p.h., and I felt a heavy brake application immediately before we crashed. . . . I at once got out of the carriage on to the ballast on the six-foot side; it was snowing very heavily, with large flakes. . . . I left the station about 6.0 p.m., after three ambulances and doctors had arrived. I cannot say when snow ceased, but I imagine that it cleared up about half-an-hour after the accident. My impression is that it was certainly snowing hard at the time, but I am afraid I was not thinking of range of visilibility and cannot really speak about it; in fact, I did not look at a signal or any object with that in my mind. My recollection is that it was dark, and the flakes were so thick that I would be quite prepared to believe that range of visibility was very much less than ¼-mile—I should have no hesitation in saying that. When the snow ceased, though I did not observe that there was a moon, it certainly got brighter due to the snow all over the country. I do not remember that there was sleet after the snow, though I am prepared to believe that there may have been some. The flakes of snow were very big. With regard to the depth of snow, I should say there was between 2 and 3 inches."*

The attendants in the restaurant car considered that speed at the time was normal, and the brake was not appreciably felt (sixth car) until the noise and grinding of the collision was realised, when retardation was sudden and articles of crockery on the tables were thrown on to the floor. The consensus of opinion was that it was snowing, but not heavily.

6. Mr. E. Cunningham, District Inspector, reached Castlecary from Glasgow by car at about 5.40 p.m. when *"there was only a very slight fall of snow and a little wind coming from the north-east direction. I consider the*

general visibility was quite good as I could see the lights of the signal box 600 yds. away." After looking at the wreckage, Mr. Cunningham went to the box and questioned Sneddon at about 5.53 p.m. He could not then see the down starter, as, in his opinion, the spectacle was obscured by snow. (As previously stated, there is no evidence to show that this signal had been worked since it was replaced at about 4.10 p.m., after the passage of the Cadder goods train.) Nor could he then see the backlight of the down distant signal; *" I think it would just be the visibility, because of a very light fall of snow at that time."* In fact, Mr. Cunningham was of the opinion that *" the lightest fall of snow would prevent you from seeing that back spec."*

Mr. J. McKenzie, the District Superintendent, Glasgow, who arrived with Mr. Cunningham, also looked for, and could not see, the backlight at this time; his impression was that the storm had then *" slackened off considerably,"* and that visibility was better than it had been. On the other hand, he had since visited Castlecary, with the object of viewing the backlight, *" and the signalman was able to see the back spec, but I could not pick it up myself. I formed the opinion that these signalmen know fairly well where to look for it and can pick it up quicker than a stranger."*

After making his inspection in the box, Mr. Cunningham walked up the line to examine the signal (at about 6.20 p.m.); he said that from a point 300 yds. east of it *" neither the arm nor the aspect of the signal was visible, and it was only when I approached to a point about 100 yds. from the signal that I could see the light. On getting nearer the post I observed that the arm was fully in the 'on' position, although there was snow on it and also on the spectacle."* On returning, he saw the light of the down home at a range of only 30 yds., owing to the snow on the spectacle. Like the starter, it would appear that neither of these signals had been moved since 4.10 p.m., and there had been time for snow to accumulate; but this would not have applied to the backlight owing to the direction of the wind.

7. District Inspector H. A. Crorie, Shed Foreman T. H. Thomson, and Telegraph Linemen L. Robertson and A. Dickson were on the footplate of a light engine, which was in the charge of Driver T. Downs; it was running tender first from Polmont, was the first movement over the down line after the accident, and arrived at the down home signal at 5.40 p.m. Mr. Crorie said that it was snowing at Polmont while he was waiting for the light engine, between 5.0 p.m. and 5.15 p.m., but it was possible to see well over $\frac{1}{4}$-mile; thence snow was falling all the way to Castlecary; *" it blinded our view of the signals and prevented our seeing the lights until we were close on the various signals. The arms could be seen just as we were close on them by the light thrown out from the engine firebox; we saw Castlecary distant signal, both arm and light, but only when we were close on it. The arm of this signal was definitely in the horizontal position."* He had long experience, judged that visibility from the footplate was about 250 yds., and referred to the snow as *" fairly heavy."* He agreed, however, that the driver of an engine running chimney first should have got a better view of the distant signal than they did running tender first with the snow beating on to them.

Shed Foreman Thomson gave confirmatory evidence. He said that it had been snowing at Polmont on and off from about 11.0 a.m; by the time they arrived at Castlecary, 5.40 p.m., it had somewhat abated, and the weather improved a short time later. Cloud remained, but there was sufficient light from the moon to show up the snow-covered countryside. Driver Downs also confirmed Mr. Crorie's evidence, and, in saying that *" it was pretty heavy snow,"* judged that his view of the distant signal arm and light was only 20 yds.; he could see the arm and could just discern the light, both the semaphore and the spectacles being covered with snow. He returned with the light engine at 6.10 p.m. from Castlecary, and he said it was still snowing then, but the up line signal arms and lights were little affected by it, the wind being from an easterly direction.

Signalman G. McLeod took over duty from Sneddon at about 8.0 p.m. He said that he was *" not paying any particular attention to the weather";* but it was not raining, *" it was a soft snow. There were snowflakes. They were on my coat when I went into the box and I shook them off."* He thought, however, that the wind was coming from the west, and said he was able to see the backlight of the distant signal, while there was no snow on the windows of the box.

8. In order to note, as accurately as possible, the conditions of light at the time of the accident, I made an inspection on the evening of the 16th December; as compared with the mean of the times of sunset for Glasgow and Edinburgh, 3.38 p.m., on the 10th December, the time on the 16th was one minute earlier. Conditions of visibility were perfect, and the ground was covered with snow; the moon was almost full, and at 4.30 p.m. was east by north from the box, at an elevation of about 20° from the horizon.

In approaching and passing the distant signal at about 3.24 p.m., with the setting sun behind it, an excellent sky view of the arm was obtained. The Cadder goods train passed the box at 4.7½ p.m., at a speed of 25 to 30 m.p.h., and at 4.8 p.m. (equivalent to 4.9 p.m. on the 10th) I could just see the arm of the down distant signal; at 4.12 p.m. I had difficulty in seeing it, though the post was still visible, but the backlight could not be seen. At 4.15 p.m. I was definitely unable to view the arm; but at 4.20 p.m. the signalman, G. Preston (who had three years' experience in the box), said he could still see it, and the arm of the starter was also clearly visible against the sunset. However, at 4.24 p.m., Preston also admitted his inability to see the arm, nor could the backlight then be observed, though at 4.29 p.m. the engine of the Dundee express, approaching at 55 to 60 m.p.h., could be seen to be steaming in the distance. At 4.30 p.m. I could just discern the backlight; at 4.39 p.m., when the Edinburgh express passed at about 65 m.p.h., it was practically dark, and at 4.45 p.m. the backlight of the signal could be easily observed.

VIII.—Application of Relevant Rules.

The following Rules and Instructions in the Appendix dated 1st March, 1937, to the Rules and Regulations and to the Working Time Tables apply to this case:—

Rule 65.—When a Signalman operates a signal lever he must watch the signal to ascertain that it goes fully to the required position or aspect. Where a fixed signal is out of the Signalman's sight and its working is indicated by a repeater in the signal box, he must satisfy himself by means of the repeater that the signal is working properly, and if a signal light repeater or indicator is also provided ascertain therefrom that the light is burning . . . .

Signalmen must keep the signal wires adjusted by means of the regulating appliances, to compensate for expansion and contraction caused by variations of temperature.

Rule 81.—(*f*) A defective distant signal must, whenever possible, be kept at Caution, and if this can be done a Handsignalman need not be appointed at it, but during fog or falling snow, the Fogsignalman (if one is employed at the signal) must take up his duties as usual.

(*g*) When a defective distant signal cannot be placed at Caution or during the temporary absence of such a signal, a Handsignalman must be stationed just outside such signal or at the place it occupied, and there exhibit a Caution signal to the Driver of every approaching train and keep a detonator on the rail of the line to which the signal applies, until the signal has been repaired or replaced, or fixed in the Caution position . . . .

(*h*) The Signalman at the box in rear must be advised if a distant signal cannot be placed at Caution, or a home signal cannot be placed at Danger, or of the temporary absence of such a signal, or if the light is out when it should be burning, and he must stop all trains proceeding in the direction of that signal and advise the Drivers of the circumstance. Where the signal forms one of a group, all trains approaching such signals in the same direction on adjoining lines must be similarly dealt with . . . .

Rule 82.—The absence of a signal where one is ordinarily shown, or a signal imperfectly exhibited, or the exhibition of a white light where a red, yellow or green light ought to be seen, must be treated as a Danger signal and the circumstance reported to the Signalman at the nearest signal box. Should, however, the signal concerned be a distant or a stop signal worked from a box which is closed, the Driver must proceed cautiously and report the circumstance to the Signalman at the next signal box.

It will not be necessary for a Driver to inform the Signalman of a defect if previously advised by notice or by the Signalman at the box in rear.

Rule 95.—(*a*) During severe frost or falling snow, signals, points, locks and bars, must be frequently worked by the Signalman when the section is clear and no train has been signalled, in order to prevent frost or snow impeding the working of such apparatus.

(*b*) Fogsignalmen must see that nothing interferes with the true working of the arms and lights of the signals for which they are fogsignalling; that the signal arms, lamp glasses and spectacles are kept clear from snow; and, as far as practicable, that the wires work freely over the pulleys. The Fogsignalmen must at once report to the Signalman any defect in the signals or impediment to their proper working. If Fogsignalmen are not employed, the Ganger must provide for this duty being performed . . . .

Rule 127. The Driver MUST—

(iv) observe and obey all signals, whether the cause of the signal being shown is known to him or not, and when owing to fog, falling snow or other cause, the fixed signals are not visible at the usual distance, use every precaution and reduce speed if necessary, especially in approaching stations or junctions, to enable the train to be stopped at the signal should it be at Danger.

(xvi) have his Fireman disengaged, as far as practicable, when approaching or passing a signal box, so that he also may keep a good look-out for signals.

(xvii) be vigilant and cautious and not trust entirely to signals.

(xxii) during fog or falling snow, keep a sharp look-out for the Fogsignalmen, who, except as prescribed in the first paragraph of Rule 91, clause (*f*), will repeat the indications exhibited at the fixed signals by showing a red, yellow, or green hand signal, as the case may be, held steadily. When the fog is so dense that the fixed signals cannot be seen by the Driver on approaching them he must, in the case of a distant signal, unless he can see the Fogsignalman's hand signal, assume that that signal is at Caution and proceed accordingly. Where a stop signal is concerned he must, unless he can see the Fogsignalman's hand signal, assume that the signal is at Danger and stop his train immediately.

Appendix dated 1-3-37—Fog or Falling Snow.

(*h*1) Instructions to Drivers—Rules 82. 127 (iv), (xvi), (xvii), (xxii). . . .—No risk whatever must be incurred, the first consideration being safety.

(*h*2) Accidents have occurred through signal arms being weighed down with snow, whereby a "Clear" instead of a "Danger" signal was shown to Drivers, who, in the case of Distant signals, assumed the line through the station or junction was clear, and were unable to pull up on sighting the Stop signal at "Danger".

In connection with Rules 81 (*f*), (*g*), and (*h*), which provide for action in the event of signals becoming defective, Mr. R. Gardiner, the Superintendent, Southern Scottish Area, stated that it was intended, and was the present practice, that Rule 81 (*h*) should be applied when the arm or backlight of a distant signal could not be seen by the signalman, and the signal was not repeated in the box; he considered that the words *"or of the temporary absence of such a signal"* covered these conditions. This rule has existed substantially in its present form since 1923, and in order to bring the Southern Scottish Area into line with the other Areas of the system, the following Clause 4 (*b*3) of the October, 1922, Appendix to the North British Railway Company's Working Time Tables and Book of Rules and Regulations was omitted from the current Appendix when it was published on 1st March, 1937:—

4. *Foggy Weather or Falling Snow—Rules* 58 *and* 78 *to* 86 *inclusive.*

(*b*3) In all cases where the Signalmen are not perfectly satisfied that their Distant Signal Arms are going properly to Danger no train must be accepted from the Box in the rear until it has been offered to and accepted by the Box in advance.

With regard to the signalman's duty of observing track circuit indicators, the relevant Instructions on page 43 of the Appendix dated 1st March, 1937, are as follows:—

(*o*1) Observance of Track Indicators.—Signalmen must, as far as possible, watch the action of the electrical indicator each time a train passes on to or off that portion of the line to which the indicator applies, and if it fails to give a correct indication, must send a telephone or telegraph message to the Telegraph Lineman for the district, using the words "Track Failed". The Station Master must also be advised and the instructions in clause (*n*3) carried out.

(*n*3) Should a track circuit at a Stop signal holding the block indicator to "Train on Line" fail in such a way that the block indicator is held permanently to "Train on Line", the failure should be treated as a block failure in accordance with Regulation 25.

IX.—MAIN FEATURES OF THE EVIDENCE.

Having regard to the foregoing accounts of the weather, the Rules and Regulations, and the Instructions in the Appendix, the main features of this case are as follows:—

(1) The snowstorm and the range of visibility from the box;
(2) The stopping of the Dundee express;
(3) The aspect displayed by the distant signal when the two expresses passed it;
(4) The acceptance of the Edinburgh express; and
(5) The integrity of the track circuit and/or of its indicator in the box.

With regard to (1) and (3), Signalman Sneddon's evidence upon his vision and the working of the down distant signal has already been referred to; he asserted that, in spite of the snow, *"I could see my distant plainly go to danger"*

at 4.9 p.m. after the passage of the Cadder goods train, that he replaced the home and starter then, and that thereafter the levers were not moved. Further, notwithstanding Mr. Cunningham's evidence that Sneddon had said that he had not noticed the backlight at 4.32 p.m., Sneddon stated emphatically, on more than one occasion in cross-examination, that at 4.22 p.m. and at 4.32 p.m., when the expresses were accepted, he observed the backlight of the signal. For example, *" When I accepted the train at 4.32 p.m. that was the last time I looked at my signal to make sure."*

On the other hand, Sneddon admitted that the windows on the east side of his box were being obscured by snow, and he had to make the observations referred to by looking out from the front window, which he said he was keeping open. Indeed, he stated that *" it would have been a stupid thing to try and look out of them."* An extract of his cross-examination on the point is as follows: —

" Did you leave your frame and go to the window to observe the Distant first?—I had been watching my signals all the time.

Just answer my question?—No, I did not. I just accepted the Dundee.

Therefore, is it true to say that you did not look at the Distant signal backlight definitely before you accepted the Dundee?—Oh, yes, I looked.

How did you do it?—I always look at my signals.

How did you do it in that case?—I was watching them all the time. I was having a look out of the window and one thing and another, and I had a look out at 4.22 p.m. when I accepted the train, of course.

Did you leave your bell to go and look out of the window?—No. It was after I accepted the train that I saw my Distant was all right.

So you accepted on the bell first?—Yes.

And then you went to the window and looked out of it?—Yes.

Now, take the Edinburgh. How did you accept the Edinburgh train? Did you do the same thing again?—No. I was at the window. I was watching my signal at danger as the Dundee was coming forward.

What signal?—I saw my Distant was at danger all right before the Dundee came forward. I saw the back spec of my signal, and after he went past there was no necessity for me to go and have another look at 4.32.

You have told me that when you accepted at 4.32 you looked at your signal again?—Well, I looked at 4.30, anyway, when that man was coming forward, so it was all right, and at 4.32 before I assured Beattie that my signals were all at danger I had a good look at my signals.

How did you look at your signals when you were assuring Beattie?—Through the window.

Did you leave the telephone in the middle of your conversation with Beattie to go to look at the signal?—No, that was after the conversation.

So did you assure Beattie first that the signals were at danger and then go and make sure afterwards?—No, I made sure the signals were at danger, but I looked before I accepted the 4.3 to make certain."

Sneddon had a ready knowledge of all Rules and Instructions, and fully realised the implications of Rule 81 (*h*); but in spite of his statement that *" on many occasions I have had a mist coming up over the moor,"* between the box and the down distant signal, obliterating the latter from view, the last occasion on which he had advised the signalman at Greenhill Junction that he could not see the backlight was on the 26th November, 1932, when he closed the box about midnight to go out to re-light the signal. The following is also an extract of his cross-examination on the point: —

" Is it fairly common that you fail to see the Distant signal, yet you can see your fog object?—Well, it happens on occasions.

How often?—Now and again. I couldn't say just how often.

Is it due to fog?—As I told you, there is sometimes a mist off the moor.

Rain?—Well, rain will not obscure it very much without a mist.

And snow?—Well, I can't remember having it obscured by snow.

But you think that after the accident at 6 o'clock it was snowing so heavily that it might have been obscured, although you didn't look at it?—I didn't look at it. I might think it, but I can't be positive on that, of course. . . .

Then, have you in all your six years' experience only stopped a train once on the obliteration of the Distant signal?—I have a better way than that of working it and preventing any delays. Before I accept it from Greenhill, I bell it. These fast trains and passenger trains are all belled right through anyway: when you get them on, you offer them on to Dullatur. Wait until it is accepted from the box in advance and in that case you don't require to have them stopped at Greenhill. I have done that on a few occasions.

And you ensure that you get acceptance ahead?—No; if I am going to be refused ahead, I would refuse it.

But if you get acceptance ahead, you feel safe in pulling the Distant?—Yes.

Whether you see it or not?—Yes.

And therefore in the case of being refused ahead by Dullatur and at the same time being unable to see the signal, you then refuse to Greenhill?—Refuse to Greenhill.

Why didn't you refuse on this occasion?—It was not necessary for me to refuse on this occasion, because I saw the back spec of the signal . . . .

You do not think you were misled in this snowstorm, that you did see the back spec?—Oh, no, I am certain of it. I have been too long there watching the back spec of that signal to make any error.

Have you ever asked for a repeater?—No.

You have never felt the need of it?—No.

You have never felt the need of it, because you have always been able to get acceptance ahead from Dullatur?—Yes."

Stationmaster Scott had been in charge of Castlecary for only eight months; he generally supported Signalman Sneddon, and was of the opinion, on the ground that "*it was snowing slightly*," that Sneddon had been able to retain vision of the down distant signal, arm and backlight, from the box. On the other hand, according to his evidence, which has already been quoted, Scott neither tried to look at the signal at 4.20 p.m. from the platform when he went over to the brickworks (though he alleged that he could then see the up advanced starter), nor when he reached the box, nor after the accident. The following are also extracts of his cross-examination with regard to the application of Rule 81 (*h*):—

"What has been your practice?—To stop the trains in the rear . . . .

When was the last occasion on which that was operated?—I can't remember.

I have been given one date in September, several years ago, when the lamp was out; do you know of any occasion since you have been at Castlecary when that interpretation (of Rule 81 (*h*)) has been brought into operation?—No, I can't remember any.

Do you agree that there will be occasions when you can see your fog object, but you cannot see the distant signal arm or light?—Yes.

And do they often occur?—Yes.

I take it they have occurred this winter?—Well, fog is very bad at Castlecary, and it might be foggy on one side and practically clear on the other.

On the down side near the down distant signal?—Yes . . . .

Then your interpretation of this Rule (81 (*h*)) is that when you cannot see the arm of the distant signal you should operate like that, and warn the train in rear at Greenhill?—Yes.

You agree that that is the interpretation?—Yes.

And it is being carried out?—As far as I am aware, yes.

But you don't know when it has been carried out?—No.

How many times do you think you have failed to see the distant signal this winter?—I cannot remember that . . . .

If trains are not being warned, they are not being operated in accordance with your interpretation of the Rule?—That is right, but if the trains are warned it should be reported to me.

But you have not received any reports?—I cannot remember any.

Therefore you assume that they are not complying with your interpretation of the Rule?—Yes, there might not have been any case.

I thought there must have been cases?—Well, I said the fog is very bad at Castlecary.

And therefore there must have been cases?—Well, I could not say whether the distant would be obscured or not.

You have just suggested that it would be obscured, have you not, because of the fog?—Well, I said that the fog was really bad in some cases; it is sometimes on one side and sometimes on the other. It is coming off the canal, but I could not say if there have been any cases where the distant signal has been obscured.

Have you ever tried to see for yourself?—Yes, I suppose I would.

Have you ever failed to see the distant signal?—No.

Never?—No, not during fog or anything like that.

You have never tried to look?—Oh, yes . . . .

Are you satisfied that the signalmen have been operating in accordance with your interpretation of this Rule?—Well, I cannot say that.

Have you ever asked any of the signalmen . . . about this particular Rule?—No, I don't think I have.

You think that while you have been there the distant signal has been obscured?—From the signalman, yes.

Although he could still retain vision of his fog object?—Yes.

Does that fairly frequently take place?—No, not very often.

But it takes place during mist and fog?—Yes.

And you do not think it would have been obscured due to snow on this occasion?—I don't think so."

As already stated, Sneddon said he did not touch the levers, and made no attempt to look at the backlight of the distant signal, immediately after the accident. In view of his responsibility in this case, I have very carefully considered the question of the range of his visibility after 4.0 p.m. I agree that the calling out of fogmen would not have been justified, and I accept his evidence, which is supported by that of Stationmaster Scott, that the fog object,

the up home signal, 312 yds. from the box, remained visible. Nowhere else on the Edinburgh-Glasgow main line, except at Ratho, between 7.50 a.m. and 1.25 p.m., were fogmen called out on this date.

Having regard, however, to my observations at the relevant times, to ascertain the effect of sunset and the light of the moon on the 16th December, I have formed the opinion that, although the arm of the distant signal was just visible from the box at 4.9 p.m. under the perfect atmospheric conditions which prevailed on that date, it is very doubtful whether it would be visible in the same fading light at that time if, for instance, it were raining. Still less do I think it likely that the arm would have been visible then under conditions even of light snow, and I feel that at the later time, 4.22 p.m., when the Dundee express was accepted, both the arm and backlight were very probably invisible on the 10th. Indeed, at 4.24 p.m. on the 16th, Signalman Preston himself was unable to see either, notwithstanding the clarity of atmosphere on the latter date.

Mr. Cunningham's opinion, as the result of his observation at about 5.53 p.m. on the 10th December, is significant, and I do not think that conditions at 4.32 p.m. can have been materially better with regard to viewing the backlight, while, of course, the arm could certainly not have been seen at that time.

In other words, making due allowance for lack of experience in picking up the object (as pointed out by Mr. McKenzie), conspicuous as this particular signal may be, and having regard to the varying interests which may perhaps tend to colour the opinions of some of the witnesses concerned, it seems very doubtful whether range of visibility at Castlecary on the 10th (in the open and not through the signal box windows, and between, say, 3.30 p.m. and 5.0 p.m.) reliably exceeded 400 to 500 yds.

Excluding Signalmen Sneddon, McLeod, and Beattie, and Stationmaster Scott who supported Sneddon in the suggestion that the down distant signal could be seen 777 yds. away, the majority of the other 30 witnesses referred to ¼-mile or less. Look-out man Aitken and Lengthman Fearns certainly mentioned ½-mile looking west, and Lengthman McDonald also suggested this distance, but I do not think their evidence was very reliable. On the other hand, Driver Cairns and Guard Penny impressed me as good witnesses with regard to the visibility of signal arms at 4.0 p.m. and 4.9 p.m., respectively, while Mr. G. S. Inglis' opinion of the conditions immediately after the collision was naturally unbiased. The fact that the last-named said the snowflakes were large makes it still more unlikely that range of vision was as far as Scott and Sneddon suggested.

2. *The stopping of the Dundee express.* The circumstances in which this took place have already been briefly referred to. Sneddon's account was that, having accepted this train at 4.22 p.m., he telephoned to Signalman Smith of Dullatur East to inform him, "*in order that he might arrange to shunt the 2.50 p.m. Falkirk High-Cadder goods train, which I knew was standing at Dullatur East.*"

As a matter of fact, however, it subsequently transpired that Sneddon did *not* know—until so informed when he telephoned to Smith at 4.22 p.m.—that the goods train, which had passed him on time at 4.9 p.m., had been held up at Dullatur, and that it could not be shunted until after the passage of the 4.6 p.m. up passenger train ex Glasgow. Sneddon explained that, although he would normally have expected to receive the *Out-of-Section* signal for the goods train at about 4.14 p.m., he took no steps to ascertain from Smith what was causing its delay, because he was "*not in the habit of doing that for a train going to blocks in advance. . . . . The man the train was going to would be the man to ask if anyone was an unusually long time in the section, if he thought it had not appeared to him within the time allowed.*"

The goods train had arrived at Dullatur East home signal at about 4.14 p.m., and, although it was standing on a train-waiting track circuit which is repeated in the box, it appears that Fireman Smith reported at about 4.25 p.m., to ascertain the cause of the delay, and signed the register at 4.30 p.m. He confirmed Signalman Smith's evidence that the presence of the train was also announced by a buzzer which continued to sound, and the latter emphatically denied the suggestion that he had forgotten the train; indeed, he went so far as to say it was "*impossible*" for him to have accepted the Dundee train, even if it had been offered to him by Sneddon, which it was not. He had had no conversation with

Sneddon with regard to the goods train, and, of course, the latter also denied that he had thrown his signals up in the face of the Dundee train after failing to replace them behind the goods train, or after having wrongly lowered them for the Dundee train.

When, therefore, Sneddon received the *Entering-Section* signal for the Dundee express at 4.28 p.m., he transmitted the 1-5-5 shunt bell-signal to Smith (entered at 4.29 p.m. in the wrong place in Smith's register); but the movement of the goods train into the up loop at Dullatur East had to wait the passage of the 4.0 p.m. and the 4.6 p.m. up passenger trains from Glasgow at 4.23 p.m. and 4.31 p.m., respectively. Signalman Smith did, in fact, effect this shunt, and transmitted the *Out-of-Section* signal for the goods train to Castlecary at 4.37 p.m., viz., just before the collision occurred.

With regard to the approach of the Dundee express, Sneddon stated that *"My home, distant, and starting signals were all at danger, and as I saw the train approaching I could very well see from the speed it was travelling at that it would not stop. I went to the window (east end of box) and held a red light steadily towards the approaching train, and at the same time whistled with a railway whistle with the idea of attracting the driver's attention. The driver did not acknowledge my red hand lamp signal, and showed no signs of stopping when passing my signal box . . . ."*

Extracts of Sneddon's cross-examination are as follows:—

"How could you see that the train which was approaching you was not going to stop?—By the speed it was coming over the viaduct.

When did you realise it was not going to stop?—The other side of the viaduct; I knew by the way he was coming so fast that he was not going to stop.

You could not tell its speed?—Just the usual speed he takes up when he has line clear signals.

I cannot tell the speed of a train coming towards me. How could you tell the speed?—Neither could I, but I knew by watching trains whether he was going at the usual rate or not.

Let me help you. Didn't you realise it was still steaming? Could you see the smoke?—Well, I saw the smoke. I saw that he was just going his usual.

Did you hear it coming?—Yes, you could hear it coming, too.

This red light that you held out was a lamp?—Yes, the hand lamp for the signal cabin.

Where do you keep that hand lamp?—On the window for handiness, for being ready for an emergency.

Inside or outside?—Outside, on the ledge.

Why outside?—Well, the fumes of it make a smell in the signal cabin. We have always been in the habit of keeping it outside.

Is it a good lamp?—Yes, a very good lamp; never gives trouble.

Have you ever had to stop a train like this before which you thought was running away?—No, I cannot remember ever having had to stop one before . . . . .

What time did you display this red light?—Just as he was coming forward, about 4.29 p.m. or 4.29½ p.m.

What time did you light that lamp?—I always light my hand lamp when I light my lamps in the cabin, and that night the lamps would be lit perhaps about a quarter to four or ten minutes to four.

The lamps in your cabin were lit at 3.45 p.m., and at 4.9 p.m. you could see that semaphore arm go back to danger at 777 yards?—Well, we light the lamps before actually it is dark, for the purpose of marking up the book. The instruments are up against the window, and there is nothing at the back to show a light on the indicators, on your blocks, bells, etc., so the lamps are always lit earlier than darkness.

If, instead of holding out a red light, you had put a red flag out, was the visibility good enough for the driver to see it on the Dundee train?—No, not at 4.29 p.m. It was dark then.

But at 4.9 p.m. at 777 yards you could see that semaphore arm go back to danger?—Yes. It was too dark for a red flag anyway, but I had a good view of the arm.

How close was that train when you concluded it was running away?—Well, of course, I could not just say where, but I had time to push up the window, lift the hand lamp, turn it to red, and get the whistle; but I just would not like to say where it was.

Was he crossing the viaduct?—Yes, I think he would be coming on to the viaduct anyway, because I was watching him a good bit away to see if he was slackening. . . .

This is a passenger train and it runs fast under ordinary circumstances?—Yes.

Yet in that 200 yds. you had time to make up your mind, open the window, get a red lamp, and signal to that driver?—Well, as I told you, I could not just say where he was when I had made up my mind. I do not say he was on the viaduct or where he was. I say that I could see from the way he was coming in the distance that he was not going to stop. I did not think he was going to stop as he was approaching.

But what were the signs that compelled you to come to that conclusion for a fast train?—Well, the way he had come from the Distant signal. When a passenger train is slowed at a Distant signal you usually see him crawling a good bit away. In fact, trains that do not get the Distant signal usually crawl over the viaduct, not running as fast as he was going. . . ."

Sneddon stated that he watched the tail lamp of the train until it reached about the middle of the platform, where he suggested it became obscured by smoke (109 yds. only short of the point at which it came to rest, viz. the site of the collision). He then immediately went to the frame and sent the *Vehicles-Running-Away-On-Right-Line* signal to Smith at Dullatur East; but he said he did not look at the track circuit indicator while transmitting this long 4—5—5 bell code, though the instrument was straight in front of him. *"I can't explain why I didn't look, but I never looked. . . . That is one of the things I will never be able to explain"*; but he admitted that the train could not by that time have passed off the track circuit, even on the assumption that the train was running away and entering the section.

The front of the engine came to a stand about 468 yds. beyond the box (18 yds. ahead of the down starting signal), and, as already mentioned, this compares with 478 yds., the distance in which the test train, travelling at 58 m.p.h., was brought to a stand on the 15th December, as the result of an emergency brake application. It appears, therefore, that the speed of the train concerned on the 10th December did not exceed 50 to 55 m.p.h., and that the speeds at which the tail lamp passed the box and the centre of the platform (up to which point Sneddon alleged that he watched it) were roughly 50 and 30 m.p.h. respectively. Further relevant extracts of cross-examination are as follows:—

"Did you watch the track indicator as the Dundee train passed?—No. . . .

You did not see the track indicator until you were talking to the man at Greenhill (about 4.32 p.m.)?—Yes, I had seen it before then, but I looked at it particularly when I was speaking to the man at Greenhill.

You had seen it before then. Was it clear then?—Yes, it was clear when I first saw it.

Was it not possible to see the tail light of the Dundee train?—Well, I found the track circuit perfect in every way. It had never given me any difficulty at all, and when it showed the line clear, after seeing the tail lamp going through the station, I never looked for the tail lamp again. . . .

You assumed it had gone straight through, and never thought about it?—Yes, I assumed it was straight through.

But you agree that the visibility was so good that you could see the backlight of your Distant signal?—Yes.

That was a far more difficult thing to see than the tail light of the Dundee train?—Yes, I agree with that. . . .

You had done your best to stop the Dundee train?—Yes.

You would not expect that he could stop right away when you suddenly called his attention, or tried to call his attention, with your red lamp?—No.

You knew even if he had seen you he would be rushing through?—Yes, but I watched him as far as I could, and I could not see him slackening speed in any way.

But you were so good at estimating speed when he was approaching you?—Yes, but I could not see him slackening off at all. . . .

But you can see a tail lamp right through the station if you take the trouble to walk to the front of your box and look out through the window?—Yes.

Did you do that on this occasion?—Yes, I always look out of the window as the train is passing. . . .

And did you watch from there the train going through the station?—Yes, I watched it going through to the centre of the platform, and I rushed to the emergency bell.

From the right-hand window?—Yes. . . .

Where was the tail lamp; was it on the left-hand side, the centre, or the right-hand side?—Oh, I could not remember where it was.

But you agree you could have seen that tail lamp right through the station?—Oh, yes.

You did not try to see how far he went?—No. If I had received an acknowledgment from the driver, a whistle, that he had seen my red hand signal, then I would have been looking for him stopping at some place, and I certainly would have been in no doubt about accepting the 4.3 p.m. train then.

Before we come to accepting the 4.3 p.m. train, you seem to have made up your mind that he ignored your red light?—Yes.

And you did watch him to the middle of the platform, you say, but no further. If you had watched him a little bit further you would have seen him stop?—Yes, that is so.

And not very far?—Yes, if I had watched, but I knew the position ahead. I had been told about the goods train standing at Dullatur, and it was to give them most time to get this train stopped that was worrying me. I had the picture that that train was going right away through.

But if you had been able to gauge the speed of the train so well coming towards you, I should have thought you would have been able to gauge its speed fairly well when it had passed you. It was not accelerating when it was coming towards you, and it certainly must have been stopping when it got to the middle of the platform?—Well, watching the tail lamp, of course it may be very difficult to tell what speed it is going at, but to me the picture was it was just going as hard as ever.

Would you say it is easier to gauge the speed of the train when it is going round a curve than when it is coming straight at you?—No.

Wouldn't you?—No. I could not tell the speed it went, but if I saw one coming straight along I would have a good idea of the rate it was going. . . .

After the train had passed, you did not notice the track indicator showing occupied?—No, I never did. I was so excited. I was in an excited state, and even when I gave him the bell to Dullatur East, I thought he was taking just too long to come in fact. I was in a state of nerves at the time.

If you had failed to be out in time with your red light . . . it would have been much less likely that he would have stopped?—Yes, if I hadn't given him that red light he would have been right through.

He might have stopped even then?—Yes.

He might have seen the Home signal?—Yes, that is so.

But you would have watched very very carefully to see if he was going right away?—Yes.

Having given him a red light you did not trouble to watch very much?—If I had just received an acknowledgment from him that he had seen my red light, or even if I had seen him braking, I would certainly have had no hesitation in refusing the 4.3 p.m. train, even though I knew he was through my ¼-mile clearance. . . ."

Sneddon suggested that he had to telephone to Signalman Smith of Dullatur East because the latter failed to attend to the call-attention signal and did not understand the 4—5—5 bell signal. Smith, who had been at Dullatur for many years, and also had never before received the 4—5—5 bell signal, denied both allegations, and said that Sneddon rang him up immediately after transmitting the bell signal, at 4.31 p.m., to say that the Dundee express *" had run through his signals."*

Smith stated (and there seems to be no reason to doubt the reliability of his evidence) that when Sneddon rang him up, he expected a collision to result within a couple of minutes, and all he could do was to instruct Fireman Smith, who, as related, was in the box at the time, to *" get back as quickly as possible and tell his driver to come inside ";* the up passenger train was passing at the time, and immediately afterwards Signalman Smith was able to set the road for the movement, which appears to have taken place without undue delay, though clearly the collision, which he anticipated, would not have been prevented had the Dundee train not been stopped.

The question arises as to whether, in the circumstances, Signalman Smith might reasonably have been expected to take any action. He explained that he did not receive word from Sneddon until 4.35 p.m. or 4.36 p.m. that *" he (Sneddon) had managed to get the train stopped ";* but when asked why he had not telephoned to advise Sneddon two or three minutes previously that the collision which he expected had not taken place, Smith replied, *" Oh, I did not think of doing that."* On the other hand, he had entered 4.35 p.m. as the time of receiving the *Obstruction-Danger* signal, and explained that this had been booked perhaps ten minutes after the receipt of the signal, as *" I knew there was a train running away, and it put me off my normal way of working."*

Smith said that Sneddon gave no information as to where the Dundee train had stopped (*vide* Fireman Fleming's evidence later), but he assumed it was *" inside his signals "* at Castlecary; in fact, he heard nothing more. On the other hand, Sneddon denied, or could not remember, ringing up Smith on this second occasion, though he could recollect the first time, which was coupled in his mind with the complaint of Smith's inattention. As for Sneddon's reasons why he did not take the initiative and ring up Smith at about 4.33 p.m. to ascertain for himself whether the collision, which he said he anticipated, had occurred, the following are extracts from his cross-examination:—

" Were you aware that the goods train was standing at the Home signal?—Yes, I knew it was there, just standing at Dullatur East.

Therefore didn't you imagine that the Dundee train might collide with it?—Yes, the picture in my mind was that at this time the train was away through the section and there was likely to be a collision at Dullatur East. . . .

Are you quite certain that you did not telephone either to Greenhill or to Dullatur East?—Well, I was very agitated at the time and excited through that train running through my signals, and I was a little excited about what might happen at Dullatur, but I cannot remember speaking to anybody until *after* the accident, from the time the man entered the cabin . . . .

How did you come to miss that tail light as it went through the station?—Well, I left the window when the train had travelled halfway through the platform to get the emergency bell signal through to Dullatur.

Then why did you not concentrate your mind on the train that had run away?—Well, I saw no signs of it stopping. I thought he was away right through to Dullatur.

Then if you did think that, why did you not wait to hear? You imagined an accident would happen at Dullatur?—Yes, I thought it must have occurred.

Why did you deflect your mind from the train that was running away to the train that was going to approach?—Well, it is so important that any delay to passenger trains must be avoided. My section I considered clear to Greenhill. I considered that I had created no emergency as far as my section from Greenhill to Castlecary was concerned . . . .

You had already telephoned to Dullatur, hadn't you, to tell him you had sent this signal (4-5-5)?—Yes.

What did he say and what did you say?—I told him that that was the Dundee that had gone through the sticks, and he said, 'Oh, God.'

Why didn't you wait for a minute and a half? Why didn't you wait to hear that the collision had taken place?—That is what I cannot explain."

During Sneddon's final examinations, however, on the 11th February and 24th March, he suggested that his reason for not having rung up Smith was that *"I thought he would be outside the box stopping the Dundee train."*

3. *The aspect displayed by the distant signal when the two expresses passed it.* With regard to this, Driver Macaulay's subsequent conversations and actions are of importance. He told Fireman Fleming that the signal was in *"a drooping position"*; his words to Guard Inglis were *"I thought the distant was off, but it may just have been drooping with the snow."* Neither of them knew until the penultimate day of the Inquiry, 11th February, that Macaulay, seriously injured as he was, had gone to the box at about 6.0 p.m. when Telegraph Lineman Robertson was present.

The latter's account of Macaulay's conversation with Signalman Sneddon was *"He asked the signalman if he had a repeater on his distant signal, and the signalman said 'No.' The driver said he had got a clear signal when he passed it, and the signalman lost his temper. He said 'Oh, don't come that stuff,' and the driver said 'There's no use getting angry about it,' and he then went down the stairs."* Sneddon's account of this conversation does not differ materially, except with regard to the position of the arm:—*"The first thing he asked me was if I had a repeater on the down distant, and I told him 'No,' and he said it was drooping. I told him not to come that stuff, or something like that, and he told me not to get angry."*

On the other hand, as already mentioned, Macaulay volunteered a statement on the 11th December as follows:—*"On approaching Castlecary the distant signal appeared to be standing in the clear position, and on nearing the signal box I observed a red lamp being shown by the signalman, and an immediate application of the brake brought the train to a stand at the advance signal which was standing at danger."*

On the 21st January, when he had sufficiently recovered to attend my Inquiry, he repeated that he viewed the arm in its clear position (tested by model 31° to 32°); he estimated that his range of vision was 150 yds., and that speed was about 50 m.p.h. He said that the signal arms were white with snow, and he had observed no lights after leaving Philipstoun, where there are colour-lights. He stated that his reason for going to the box was *"to check my time stopping, and I went back to see exactly what it was . . . . I just asked the signalman what time it was when he booked us passing . . . . I asked if the signal was right, if the signal was off. He said 'No, your signal was at danger,' and I said 'That's all right,' and I left the box then."* Macaulay added that he did not know whether there was a repeater, and he merely asked the two questions referred to above.

As already stated, Driver Anderson, travelling at higher speed, said he made his observation at no more than 50 to 100 yds. (and he also looked back), and judged, by model, that the arm was about 37° from the horizontal. *"It may have been more; I would not swear to it, but I know it was fairly well off."*

On the general question of his speed and the reliability of his observation under the prevailing conditions, the following is an appropriate extract of his cross-examination, giving his point of view:—

"I passed Greenhill, I know, just shortly below my time and I never altered my engine. I must have been travelling about the same speed all the time.

In this weather condition and this variable visibility, why didn't you slacken speed?—Well, from a driver's point of view his faith is pinned on the distant signal, and it is the position of the distant signal that makes the driver act accordingly. Had the distant signal been on, I would have applied the emergency brake . . . .

In fact, you drive with the regulator open until you see the distant signal?—Yes . . . .

Do you think that was a really cautious method of driving?—Oh, yes.

That is your normal method?—Yes . . . .

Do you know exactly what your booking was?—I think I was fully half a minute late.
And you had intermittent snow all the way from Ratho?—Yes.
Do you consider it was quite safe to run at normal speed?—Yes.
Under abnormal conditions?—Yes, I was just merely timing the train.
Do you know of any Rule which warns you to reduce speed when you have not got your normal vision of signals?—Yes . . . . .
Did you act to that Rule?—I don't think I was outwith the Rule. If I had been exceeding my speed, or before my time, I would certainly have said so, hut I was not; I was just running my time and I was working according to the distant. If that distant had been on I would have stopped.
If you see a distant at 50 yards range, are you quite entitled to run at normal speed?—If you have a good distance between your distant and your home and you think you can stop."

With regard to Anderson's previous experience, it was so long since Castlecary down distant had been against him that he could not remember the last occasion (apparently more than six months previously) when it was adverse; in fact, he said it was usually clear. On the previous day, however, with this train, he had noted a faulty distant signal at Polmont; it was showing half yellow and half green. He applied the brake, slowed down to 15-20 m.p.h., crossed the footplate, and shouted to the signalman that the signal "*was not coming off.*" The entry in the register was "*Signals sticking and foreman ganger sent for at 4.25 p.m.*" It was due to frost, and Mr. W. A. Fraser, the Company's Engineer, reported as follows:—

"This matter has been investigated and it would appear that when the signalman pulled his signals for the 2 p.m. train ex Dundee on the 9th December, he observed that the arm repeater in the signal box for the down main distant signal was showing 'Wrong.' Apparently the signalman attempted to remedy the matter by repeating the pull and also by adjusting the wire, hut without success. When he replaced the lever controlling the down distant signal to its normal position in the frame, the arm repeater in the cabin indicated that the signal had correctly returned to the 'On' position. When pulling the signal for the 4.3 p.m. express passenger train from Edinburgh to Glasgow, the signalman experienced the same trouble. The driver of the Edinburgh train reduced speed and when passing the signal box gave an indication by the movement of his arm that a signal was not properly in the 'Off' position, and the signalman concluded that the signal referred to was the down main distant. The signalman formed the opinion that the signal had been affected by the weather, and he requested the staff at the Station to obtain the services of a lengthman. The District Superintendent states that when the lengthmen arrived at the signal post it was found that the Polmont Junction down main and branch distant and Polmont East down home and down loop line signals, all of which are carried on the same post, were stiff apparently due to the frost. They attended to the signals (all of which were of upper quadrant type) and oiled the mechanism, and before leaving were satisfied the signals were responding properly to the movement of the levers in the signal box.

At the District Officers' inquiry it was ascertained that the slot repeaters in both the Polmont Junction and East signal boxes were showing 'Off' and the arm repeater in Polmon Junction box 'Wrong.' It was clear that the weather conditions on the night in question were responsible for the Polmont Junction down main distant signal arm failing to come fully 'off' and that no action on the part of the signalmen concerned could have obviated this."

The temperature at Polmont at the same time on the previous day, when Anderson had the above-mentioned experience due to frost, appears to have been been about the same as it was next day, though the thermometer was falling rapidly.

With regard to the Castlecary down distant on the 10th December, I think there can be little doubt that *if* it was displaying a *Clear* indication, as Macaulay and Anderson stated, this must have been due to failure of the arm to return to *Caution* (due to frost and snow, assuming that the lever was replaced to normal after the passage of the Cadder goods train), rather than to weight of snow (which had, however, been at its heaviest shortly before) making the arm "*droop.*" Calculation shows that it would have required a thickness of 3½ ins. and 7½ ins. of snow to cover the arm to bring about a droop of 9° and 15°, respectively. Drawing D gives the relevant dimensions and, as already stated, the pulling back power of the spectacle and counterweight amounted to 58 lbs., viz., the force at the post available to return the arm to *Caution*.

With regard to the run of wire, which was dead straight, the only place which I noticed where unusual friction (and that slight) may have been taking place was where the wire was resting, and had made a small ridge, upon the longitudinal timber batten footway of a short span underbridge, some 118 yds. from the signal; two or three nails had been driven to prevent the wire from falling into the space between the battens. This appeared to be the most likely,

and probably the only, place where the wire might have been held by frost sufficiently to have had material counteracting effect upon the pull of 58 lbs., if, for instance, temperature was low enough for this to occur; the boards were covered with 2 ins. or 3 ins. of snow and the wire lay flat on them.

The only other place in the run of this wire to which consideration has been given was the leading-off wheel outside the box. According to the evidence, Ganger Bell, or his men, brushed the snow off this wheel and from the wires and rods immediately in front of the box, before they left duty. It appears that they were then reasonably satisfied that all the equipment was working properly. But this may have been prior to the passage of the Cadder goods train, and the leading-off wheel had, it was assumed by Signal Fitter R. Wilson, frozen about midnight of the 6th-7th December (when temperature was much lower, namely, 24°) and had prevented the signalman (N. Marr) from lowering the signal.

Wilson was cross-examined upon this occurrence, and said he had come to the only possible conclusion, after careful examination of the run of wire, including the signal, that although he found the signal was again working satisfactorily when he tested it, Marr must have unconsciously loosened the chain and leading-off wheel during his previous attempts to pull the lever, and must have just stopped trying the lever when actually the wheel had become released. *"The only thing I could account for it would be the frozen snow. . . . The snow was soft on the Monday (6th December), but it started to freeze on Monday night. . . . The wheel was pulling through snow. It was the only obstacle I could possibly see. I had no other conclusion to come to."*

During 11 years' service, Wilson, who appeared to be a reliable witness, had not experienced such a thing before; he *"cleared snow from wheel and chain,"* and left instructions for salt to be applied. On arrival again at Castlecary on the 11th December, he found the wheel clear of snow; it was his duty to oil it, and it appeared to be satisfactorily maintained, as did all the equipment. Wilson had been in charge of Castlecary for 18 months and had had no previous trouble with this signal; nor had he, in fact, received complaints of any distant signal failing to return to *Caution* during normal working hours.

With regard, however, to the possibility of this same leading-off wheel freezing on the evening of the 10th December, and preventing the release of the tension in the wire and the return of the signal to danger, instead of preventing the wire being pulled to lower the signal, Mr. Fraser expressed his opinion as follows:—*"Of course, it is logical to this extent, everything being equal; the signalman exercises a bigger pull when he is drawing back, but, as Wilson said, you might have a signal lying at danger for about ¾-hour, whereas one is clear for only 5 minutes; you cannot divorce one from the other. In short, it would not be unreasonable to say that with a longer freezing period and the heavier grip or pull used to reverse the lever, the position might not be any worse than with the lesser drag on the wire and the shorter freezing period."*

It appears that, if the signal, as was affirmed by Signalman Sneddon, returned properly to *Caution* after the passage of No. 1446 special goods at 3.40 p.m. and of the 3.41 p.m. down passenger train which stopped at 3.59 p.m., the signal must have been worked for the last time at 4.5 p.m. for the Cadder goods train. On this assumption, and if the signal did, in fact, remain in a false-clear position when the lever was replaced at about 4.9 p.m., it was therefore during this short interval of about four minutes that the conditions were set up which brought about the failure and prevented the arm from returning to its proper horizontal position. In addition, however, to the freezing of the wheel itself (if temperature was low enough), such adverse conditions may have been brought about from various causes or a combination of them, viz. the lever replaced too gently combined with overtight wire; friction through snow and frost preventing the wire running as freely as usual, and snow on the wire itself or in the pulleys.

With regard to the adjustment of the wire for tightness on the 10th December, Signalman Sneddon's evidence was that he had had no cause to touch the adjuster and that the signal was working satisfactorily. As already stated, the wire had been renewed in August, 1936, and Signal Fitter Wilson had, on the 24th November, 1937, increased its length by about 15 ins., by renewing and lengthening a portion between the box and the leading-off wheel. This had been done at the request of Signalman G. Preston on the 18th November to provide added length for the purpose of regulation, as the nights were getting colder.

This does not seem to have been an unusual precaution to take in the autumn, and Wilson stated that this lengthening presented no risk of wire, instead of chain, being drawn round the leading-off wheel. The incident appears to have had nothing to do with what happened on the 6th or the 10th December, and no other complaint had been received with regard to the operation of the signal. The results of certain tests in this respect, which were subsequently carried out at my request, are given in Appendix VI.

With regard to the general question of failures of distant signals for the year 1937 in the Scottish Area, the statistics prepared by Mr. Fraser relating to cases of failure to return to *Caution*, or failure to go to *Clear*, upper and lower quadrants, are as follows:—

1.	Wire freezing in pulleys	33
2.	Arm spindle frozen	23
3.	Both freezing in pulleys and arm spindle frozen ...	34
4.	Wires off pulleys, or otherwise fouled	11
	Total	101

The relation between the failures of upper and lower quadrant semaphores and whether they failed by remaining in the "*on*" or "*off*" position is as follows:—

U.Q.	*L.Q.*	*Failed in "On."*	*Failed in "Off."*
74	—	51	23
—	27	14	13

Out of the above total of 101 failures, 53 occurred on the Edinburgh-Glasgow main lines as follows:—

1.	Wire freezing in pulleys	16
2.	Arm spindle frozen	13
3.	Both freezing in pulleys and arm spindle frozen ...	19
4.	Wires off pulleys, or otherwise fouled	5
	Total	53

The relation between the failures of upper and lower quadrant semaphores, and whether they failed in the "*on*" or "*off*" position for the Edinburgh-Glasgow main lines is as follows:—

U.Q.	*L.Q.*	*Failed in "On."*	*Failed in "Off."*
48	—	35	13
—	5	4	1

So far, however, as the Edinburgh-Glasgow main lines are concerned, 26 of the above-mentioned 53 failures occurred at week-ends when traffic was light or the boxes had been switched out; it seems doubtful whether the latter can fairly be characterised as failures, but one of them was a false-clear *lower quadrant* at 11.30 a.m. on 7th December at Dullatur West, due to the wire and arm fittings being found to be frozen when the box was switched in. It will be noted that there were only four other failures (safety-side) of *lower quadrant* signals, including the down distant at Castlecary on the 6th December, which has already been mentioned.

4.—(a) *The acceptance of the Edinburgh express.* A brief account has already been given of Sneddon's action, taken without delay, in calling Station-master Scott to the box; also of the gist of the two telephone conversations with Signalman Beattie at 4.31 p.m. and 4.32 p.m. before the train was accepted. Sneddon's explanation was that "*What I was not clear about in my mind was whether, having sent the 'Vehicles-Running-Away-On-Right-Line' signal to Dullatur East, I would be right in accepting the following train, even although I was satisfied I had the regulation clearance ahead of the home. I accepted the* 4.3 *p.m. train ex Edinburgh at* 4.32 *p.m.*" Extracts of his cross-examination on the point are as follows:—

> "Why did you raise the question of acceptance?—Well, I was very doubtful, never having had the 'Vehicles-Running-Away-On-Right-Line' signal before, whether I should accept the following train.

But if the Dundee train had obeyed your signals it would have come to a stand at your home signal, wouldn't it?—Yes.

When no question would have arisen over acceptance?—That is right.

Why were you concerned with regard to the acceptance of the following train?—Well, the 4.3 is a very important train, and I was afraid that if I had delayed the train unnecessarily I might be called in question.

But I gather you did not know whether you had stopped the Dundee train or not then?—No, I thought I had been unsuccessful in stopping it.

Had it entered the section?— Yes. . .

Didn't it occur to you that your signals might have been out of order?—Seeing all of my signals, I saw they were in perfect order. I saw they were standing at danger, by looking at the back specs. . .

Are you quite sure you saw that (distant) signal; you are sure it was not another light?—Oh, no. I have been in the habit of always paying particular attention to the signals when I am working them. . .

How did you come to think that your track indicator was clear?—It was standing at ' Track Clear ' when I was speaking to the signalman at Greenhill regarding the advisability of accepting the train . . . I was not too keen on taking the train.

Who persuaded you to take it?—He did not persuade me. That is the reason I had to ask for advice.

Did the signalman at Greenhill give you advice?—He advised that, provided I had the regulation clear distance and was satisfied my signal was at danger, there was nothing in the Regulations to prevent me accepting this train. . .

You realised that this running past signals, as you thought, was a very serious thing?—Yes, very serious.

And yet you took on this next train?—Well, that was the doubt I was in. That is the reason I discussed with Signalman Beattie the advisability of taking it on. . .

And you assure me you would not have spoken to Beattie in this way, nor would you have told Beattie that your indicator was clear, unless it was clear?—I cannot see myself, being so careful and taking so much pains, ringing up another man regarding the advisability of accepting a train and one thing or another, and standing looking at the track indicator and telling him the track was clear without it was at clear. . .

I take it you now realise, on reflection, that the train either should not have been accepted or should have been accepted under warning?—I should not have accepted it at all if I had known the position of the other one. I should not have even given the ' Train-Out Of-Section ' for the Dundee. . . On reflection, I should never have accepted the 4.3 at all, but there was nothing in the Regulations that I could think of to say that I was right in refusing the 4.3. . .

And as an experienced signalman you say this, that there was no Regulation to prevent you from accepting the Edinburgh express?—Yes.

Is that the basis of your evidence?—That was the conclusion we came to, the signalman at Greenhill and I. . .

In your own mind, were you doing everything you considered possible to avoid delay?—Yes, I am always very careful to comply with the Regulations."

In this connection, Mr. McKenzie stated that when he reached the box at 5.52 p.m., after the accident, he asked Sneddon why he rang up Signalman Beattie, and received the reply:—*" He is an older man than me, and a man of very ripe experience, and I thought I would ask his advice."* Further cross-examination on the point is as follows:—

" Why did you, knowing in your mind that this collision was to take place in a couple of minutes, at the same time (4.32 p.m.) send the ' Out-Of-Section ' to Beattie?—The 4.3 is a very important train, and. . . I always like to have a reasonable excuse for delaying the train. That was what was in my mind. . .

The one thing in your mind was by what excuse you would save yourself?—Yes, if I had delayed the 4.3. That was the doubt. If Signalman Beattie could have said ' Well. I am not very sure ', or something like that, then I would not have taken the 4.3, because, as it was, I was not very sure.

Was it not a sufficient excuse to you to know that the Dundee train had run away on the right line to justify your holding back the 4.3?—No, it was not. . . I cannot say it was, because of Regulation 4 and Regulation 10 (*a*). . .

Is there anything that debarred you from accepting the 4.3 if you had considered the Dundee train had entered the next section?—No, my track was clear and I had seen the tail lamp of the train passing, and I had seen the signals all at danger, and there was nothing to give me guidance but Section 4 and Section 10 (*a*).

Is your mind trained to watch the track indicator before you give ' Clear ' to any train?—Yes, I do not think anybody can ever say that they saw me giving ' Train-Out-Of Section ' for a train until it was clear on that indicator.

Was your starting, home, or distant signal for the down line pulled off for the Dundee train?—No, all positively at danger . . . .

Do you remember Beattie asking yon whether you had got ¼-mile clear ahead?—Yes.

And it was on the idea that your indicator was clear that you gave him that assurance?—Yes . . . .

You did not trouble to go to the window to see that it was so?—No. I relied solely on the indicator giving me a proper indication . . . .

Expecting a collision at Dullatur, why did you start telephoning to Beattie?—Well, that is a thing that I cannot explain . . . .

Did you do it to try and share your responsibility with Beattie?—Oh, no. No, not at all. I was responsible for accepting the train, or not accepting it.

But you have suggested to me that Beattie persuaded you in this matter?—Just advised me; didn't persuade me in any way."

(*b*) During the next three or four minutes, from 4.32 p.m. till 4.35 or 4.36 p.m., when Fleming and Scott arrived at the box, it appears from his account that Sneddon took no action with regard to the Dundee train, although he expected by that time that it would have been involved in collision at Dullatur East. During this interval, however, he dealt with the 4.6 p.m. up passenger train, from Glasgow to Thornton, which entered the section at Dullatur at about 4.31 p.m. and passed Castlecary and Greenhill at about 4.33 p.m. and 4.35 p.m., respectively, according to the train registers. Extracts of his cross-examination regarding this period are as follows:—

" What else did you do in this long period from 4.32 to 4.36 besides handling that up train?—I remember attempting to get on to the Control on two occasions on the telephone.

Did you get on?—No, the telephone was engaged on both occasions.

That did not take very long?—No.

What else did you do?—I also remember having a look at Regulation 23 regarding the acceptance of a following train, but whether it was before 4.32 or between 4.32 and 4.35 I do not remember . . . .

What else?—I cannot remember doing anything else.

You didn't look out of the window?—No.

And during all that time you didn't look at your track indicator?—It is quite possible I did look at it, but I cannot recollect . . . .

How do you account for not having looked at the track indicator after 4.32 p.m.?—I say it is quite possible that I did look at the indicator, and if it was still in ' Track Clear ' position it would not matter very much whether I looked at it or not. I would have paid no particular attention.

Are you sure it was not at ' Track Occupied '?—I am quite positive.

How can you say you are quite positive if you are not certain whether you looked at it?—I am positive that I looked at it very keenly at 4.32.

I am asking you about between 4.32 and 4.36?—No, I can't say anything about the track indicator between 4.32 and 4.36 . . . .

Because you didn't look at it?—Yes. It is possible, I say, that I did look at it, and if it was still at ' Track Clear ' I wouldn't worry about that, but if it had been at ' Track Occupied ' then I would have noted it.

You cannot therefore tell me whether the track was occupied or clear between 4.32 and 4.36?—No.

In spite of the arrival of the fireman?—No.

And didn't the Stationmaster look out of the box when he arrived?—Yes, I think he went to the window.

In spite of that, you did not look at the indicator?—No. I had got ' Train-Entering-Section ' for the Edinburgh immediately.

Immediately he arrived?—Yes, just a matter of seconds after he came in the cabin."

With regard to what happened on the arrival of Fireman Fleming, the statement which was drawn up, and which Sneddon signed, at the Company's Inquiry on the 12th December, was as follows:—

" At 4.36 p.m., I received the ' Train-Entering-Section ' signal for the Edinburgh train, and to make sure that it would stop, keeping in view that the 2.0 p.m. Dundee train had run through my signals and was, so far as I knew, continuing towards Dullatur East, where it might become involved in mishap with the goods train that was standing there, I intended to go downstairs to lay three detonators outside the signal cabin, but before I went down the fireman of the 2.0 p.m. from Dundee arrived at my box. He was wearing a showerproof coat and I did not recognise him as a fireman, so I asked him who he was, and he told me he was the fireman of the 2.0 p.m. I asked him where his train was standing, and he stated ' Through the starting signal '. Realising then that the train was standing just outside my starting signal, I rushed downstairs with a red lamp and ran across the viaduct to try to stop the 4.3 p.m. Edinburgh train, but, unfortunately, I was not successful in doing this. Although I got the three detonators down, I only heard one explode. The detonators, however, were placed hurriedly and no doubt the other two had not been correctly in position, which explains their not exploding."

On the other hand, Fireman Fleming (who had lost no time in reaching the box) gave a very different account (signed) of what was said on his arrival:—

" I went into the signal box and said to the signalman ' What is wrong? ' He asked me ' Who are you? ' I said ' I am the fireman of the passenger train '. He said ' Thank God, you've stopped '. After that I went to sign his Train Register Book, and I noticed that the signalman rushed to the telephone. The stationmaster entered the cabin at that time. I was signing the Train Register Book and the signalman was at the 'phone. I heard the signalman say to someone that we had stopped in the section. I turned and corrected him. I said ' We are standing at the starting signal '. The next thing he left the 'phone and

said ' I'll have to see about getting the 4 o'clock stopped '. I said it was time there were detonators on the track. He left the signal box first and rushed down the stairs in front of me. I followed the signalman in the direction of the home signal and I saw the Edinburgh train coming."

An extract also of Stationmaster Scott's statement relating to what transpired when he got to the box is as follows:—

" The signalman repeated that the 2 o'clock Dundee to Glasgow train had run through the signals, and I looked out of the window and saw the tail lamp of the 2.0 p.m. Dundee train; then the signalman told me ' That's the Train-Entering-Section signal for the 4.3 p.m. passing Greenhill ', and I ran for the detonators. The signalman got his hand lamp and ran down the viaduct, and was showing the red light to try and stop the 4.3. All levers were back in the frame."

Scott stated that he did not see Fleming going down the platform in front of him; but *" he was entering the box when I was just about three or four yards from the foot of the cabin stairs."* Scott was in a hurry and running. He affirmed, however, and was supported by Sneddon, though not by Fleming, that he heard nothing of the above-mentioned conversation, but that the *Entering-Section* signal for the Edinburgh express was immediately received and that the only word he himself uttered was *" Detonators,"* before leaving the cabin behind Sneddon. Indeed, the lengths of time (tested by watch) which he suggested elapsed between his entry into the cabin and the *Entering-Section* signal and the train rushing by were merely 4 and 45 seconds respectively. Extracts of his cross-examination on the point are as follows:—

" And you are prepared to tell me that no words were spoken between Fleming and Sneddon?—Not during the time I was in . . . .

Then you would not accept Sneddon's or Fleming's statement that conversation did pass between them?—It might have passed but it would be before I went into the box . . .

It was a matter of seconds only between the time of Fleming's arrival and your arrival?—Yes.

Could any conversation have taken place between his arrival and your arrival?—Quite possibly, yes.

Could any lengthy conversation have taken place?—No, it could not . . . .

I gather you entered the box under the conviction that the Dundee train was standing outside the starter?—Well, I didn't know that he had run through his signals, but I formed the opinion, where the train was standing, he was standing through the starting signal . . .

And therefore clear of the track circuit?—Yes . . . .

Did you suggest to Sneddon that the train was beyond the starting signal?—No.

Where did he tell you he thought it was?—He didn't say anything at the time; he only told me the 2 o'clock had gone through the signals when I entered the box . . . .

Where did you think it was?—I could not tell you from the box, because I only saw the tail lamp very faintly from the box.

When you left the box under what impression were you as to where the train was standing?—I took it to be still standing outside the starting signal . . . .

And not in rear of it?—Not inside of it, no.

And you didn't hear Fleming inform the signalman where the train was standing?—No, I did not.

And you didn't hear the signalman ask Fleming where it was standing?—No.

Did you not think it was your duty to find out actually what the position was?—Yes, but you must realise I was only about 3 or 4 seconds in the box before Section was received for the 4.3. I did not realise the position until I arrived at the box."

On the other hand, Fleming, tested by watch, estimated that he had been in the box for no less than a minute when Sneddon left with the detonators, and that a further 56 seconds elapsed before the Edinburgh express rushed by; this total of nearly 2 minutes, which corresponds with Fleming's signing of the train register at about 4.35½ p.m., and the time of the accident as 4.37½ p.m., compares with Scott's suggestion that he (Scott) was in the box for only a few seconds, and that only 45 seconds elapsed from the time of his arrival till the Edinburgh express rushed by. Fleming's cross-examination on the point is as follows:—

" Did the signalman say anything after ' Thank God, you've stopped '?—Well, he said ' Did you see my lamp '? . . . . or something, but I never answered him. I didn't know what lamp he was talking about. I was unaware of that. I asked him what was wrong ahead, and he said there was a goods standing at Dullatur. Those are the actual words that were used . . . .

Is it true that you corrected him as to what he was saying with regard to the position of the train?—Yes.

Is it true that Sneddon asked you where the train was standing?—No, he never asked me that.

Is it true that you said '*through* the starting signal'?—No, I didn't. I said *at* the starting signal' . . . .

And you corrected him while he was speaking on the telephone?—Yes.

What did Sneddon say or do when you corrected him?—As far as I can remember, he just turned round and he said then 'I'll have to see about getting the 4 o'clock stopped' . . .

Did you have any doubt that Sneddon knew where your train was after you described the position as *at* the starting signal?—No, I didn't have any reason to . . . .

And the stationmaster was there at the time?—Yes, in the cabin at the time . . . .

Is it also your impression that the stationmaster knew where the train was standing at that time?—He should. He was in the cabin and heard what I said.

And are you sure that the signalman didn't ask you where the train was standing?—Positive; never asked me that."

Signalman Sneddon's denial and contradiction of Fleming's account is illustrated by the following extracts of cross-examination on this point:—

"Is it true that the fireman told you that the train was standing *at* the starting signal?—No . . . .

Then what impression did the fireman's conversation leave on your mind?—Just the impression that I had been successful in stopping him, but that the train was *through* the starting signal. . . . The whole of the train clear of my track.

Even as the result of what the fireman had told you?—Yes, standing *through* the starting signal.

When Fleming arrived were you talking at the telephone?—No, I was not.

What were you doing?—I was standing over near the telephone at the time, just at the side of the telephone, but I was not speaking.

Then, when you spoke to Fleming, do you suggest that Stationmaster Scott was not in the box?—No, he would open the door just immediately after that.

Do you think Stationmaster Scott heard what you said?—I don't think so.

Are those the only words you exchanged?—Yes, before I got the Section for the Edinburgh.

Then how long was it after they came in that you got the Section for the Edinburgh?—Oh, it was just a matter of seconds . . . .

When Fleming told you where the train was, you felt relieved that it had stopped, didn't you?—Yes, I felt relieved.

And you realised that the collision at Dullatur had been avoided?—Yes.

Did you then look at the track indicator?—No, I never looked at it then.

Why not?—Because with him telling me he was standing *through* the starting signal, I had no idea that the train was *inside* my starting signal.

Did you then use the telephone after Fleming spoke to you?—No. I cannot remember using the telephone.

Would you accept it if Fleming says that you were on the telephone, and that you used it after he spoke to you?—No.

Then do you contradict Fleming?—Yes.

Do you suggest Fleming is telling an untruth?—Well, I never used the telephone . . .

When was the last time you used the telephone before you left the cabin?—It would be when I was speaking to Beattie regarding the acceptance of the Edinburgh train.

Do you suggest you did not use the telephone between 4.32 and 4.36 p.m. when you left the box?—I cannot remember using the telephone anyway.

But you can remember, for instance, looking at the distant signal at 4.32 p.m.?—Yes, I saw the distant signal.

Do you remember Fleming correcting you . . . . he alleges that he corrected you . . . . is that all quite wrong?—No, he never did . . . .

Do you suggest that the fireman meant his train was beyond the starting signal?—Yes. . . .

Did not the arrival of the fireman prompt you to look at your track indicator?—No, when he told me he was standing *through* the starting signal I was quite satisfied.

Do you mean to tell me you did not look at your track indicator then when Fleming came into the box?—No, I cannot remember looking at my track indicator.

But you had looked at your indicator just before when speaking to Beattie, hadn't you?—Yes, that was before that. . . .

And you looked at your indicator again when you returned to the box?—That was when I was sending 'Obstruction-Danger'.

And you did not look at the indicator when the train was passing over the track circuit when you were sending the 4-5-5?—No."

(*c*) On the passing of the Edinburgh express and the occurrence of the collision, Sneddon and Scott returned to the box; extracts of Scott's cross-examination are as follows:—

"What did you say to the signalman?—I told him to send Obstruction-Danger on both sides.

What did you say with regard to the position of the Dundee train?—I did not say anything then.

When you went back to the signal box with the signalman did you know where the position of the collision was?—No.

Then you had no idea where the position of the collision was until you got on to the ground?—Until I got along, yes.

And when was that?—Immediately.

When did you start suggesting to the signalman or to anybody else that the Dundee train had stopped beyond the signal and had moved back?—Well, I didn't suggest that.

Didn't you?—When I went back after I went along to see where the actual position of the collision was and what had really happened, I came back to the signal box to 'phone up the Control, and while I was waiting to get connected through the signalman asked me then if it was bad, and I said yes, it was very bad. He said then ' Where is it? ' I said ' It is inside the starting signal ', and he said ' Well, my track showed clear '; when I mentioned that to him, he said ' Well, I took the train to be standing outside the starting signal '. That was all that was said.

And what time was *this*?—That *would be about 10 minutes or 5 minutes to 5* . . . .

You are quite certain you then made it clear to Sneddon where the collision had occurred?—Yes . . . .

And you made no suggestion then to Sneddon that the train had moved back?—No . . . .

But did you agree with the suggestion?—Yes, I did.

Why?—Well, where I took the train to be standing then I expected the collision to have taken place further forward nearer the signal.

Had you looked at the indicator when you went into the box?—No . . . .

Then when you went back to the box at 4.50, did you look at the indicator?—Yes.

And it was showing occupied?—Yes.

And it was then that Signalman Sneddon suggested to you that the indicator had failed?—No.

What was *his suggestion then?—He only* said to me that his track showed clear after the Dundee went through.

And he also suggested that the Dundee had pushed back inside the starting signal?—Yes, he said it must have pushed back.

And it was his suggestion and not yours?—No, it was not mine.

Yet you supported the suggestion?—Yes.

On what grounds did you support it?—Well, as I said, where I took the train to be standing I thought the collision would have taken place further forward nearer the signal. I was surprised when I went along and saw it was far inside the signal."

Sneddon appears to have left the same impression on Beattie's mind when they discussed the matter at 4.40 p.m., when Sneddon completed his Train Register entries with Beattie's assistance in respect of the Edinburgh express. Extracts of Beattie's replies to questions are as follows:—

" What was your impression of what Sneddon told you?—My impression at the time was that the Dundee train must have been setting back.

Did you suggest that to him or did he suggest that to you?—Well, by the general conversation it must have occurred, because he indicated to me that his track was absolutely clear and that ran the length of his advance signal, and he was certain that the train was continuing right on. He said ' He is away to Dullatur, right through all my signals ', so naturally I took it that the train was actually away through all these signals, and if the actual impact took place about his starting signal, then the only conclusion I could come to was that the Dundee must have been propelling back and met the oncoming express . . . .

What did he mean by saying that he had ' got everything '?—Well, he meant, as far as the Rules and Regulations were concerned, he was entirely free from any blame.

And why was he free from any blame?—Because he had all the qualifications necessary for accepting a train with a clear road.

On the assumption that the track was clear when he accepted the train?—That is correct. All his signals were at danger, and he saw the tail light of the last train. Those are the Regulations that apply to our block working.

Then the whole of his suggestion to you was that the train had moved back?—That is correct.

He did not suggest to you then that the track circuit had failed?—No, he made no suggestion to me about that . . . . I think it was mentioned coming through in the train at the first Inquiry (12th December). He spoke to me about it . . . . "

In support of this allegation, Sneddon at first asserted that Stationmaster Scott had actually observed the track circuit indicator clear when he reached the box, but Scott strenuously denied this, as he also denied hearing the conversation between Sneddon and Fleming, though, as related above, he adhered to the suggestion that he formed the opinion at the time, and entered the box under the same impression (in support of Sneddon's evidence), that the Dundee train had come to a stand *" through,"* and not *" at,"* the starting signal.

The evidence, however, makes it appear that there was a misunderstanding between the two men in this respect, Scott having referred to the train clearing the track circuit, Sneddon's suggestion being that Scott referred to the indicator, thus providing a witness to support Sneddon's contention. There is confirmation of this in Signalman G. McLeod's account of his conversation with Sneddon when relieving him at 8.0 p.m., after which time the latter remained in the box till about 10.30 p.m.

McLeod said that Sneddon related some of the circumstances, including the conversation with Fleming but not that with Beattie, and referred to Station-master Scott as a witness that *" the Dundee train had run through all his signals and cleared the track. I asked him if he had witnesses and he said 'Yes.' I said that was all he wanted. He also told me that after he accepted the* 4.3 *he observed the track indicator was at the occupied position."*

McLeod clearly gained the impressions, from what Sneddon told him, that the Dundee train must have set back inside the starting signal, that Sneddon knew where the collision had taken place, and that he had seen the indicator showing occupied *after* his acceptance of the Edinburgh train, but *before* he left the box with the detonators. The following extracts of his cross-examination illustrate the impression which Sneddon left on his mind:—

" Did Sneddon make any suggestion to you then that the track circuit had failed?—No . . . .

Did Sneddon leave you with the impression that he thought the Dundee train had come back on to his track circuit?—Yes; well, I understood that . . . .

So, therefore, it is quite definite that Sneddon meant, and you understood, that his track circuit was occupied before the collision took place?—Well, he didn't actually say that. The impression I gained from his statement was that the track indicator was definitely in the ' occupied ' position, after he had accepted the 4.3, but prior to the accident.

Did he say anything about the track indicator before he had accepted the 4.3?—What he told me about the track indicator was that he saw it in the clear position after the Dundee train had passed the signal box, and again after accepting the 4.3 he saw it in the ' occupied ' position.

Your impression is that ' after accepting the 4.3 ' means *before* the collision?—Yes, definitely . . . .

Did he tell you he had spoken to Beattie?—No.

Did he lead you to think that when he accepted the Edinburgh train the track indicator was showing clear?—Yes, definitely.

When was it suggested to you that the track circuit or indicator had failed?—Well, I don't think that suggestion was ever made to me . . . .

The only thing in your mind then on that night was that the Dundee train had set back?—That was all I could conclude from the thing."

Before Sneddon's conversation with McLeod, he had also discussed the matter briefly with Telegraph Lineman L. Robertson when the latter arrived at the box at about 5.45 p.m. (As previously mentioned, he came by light engine.) Robertson said that Sneddon *" told me that the Dundee had run through all his signals, and that he saw the track 'Clear.' He spoke to Signalman Beattie on the 'phone, and after accepting the* 4.3 *p.m. train, he looked at the track (indicator) again and it was showing 'Occupied.' I understand that Signalman Sneddon told the same story to Telegraph Lineman Dickson, Polmont, in the presence of Relief Signalman McLeod."*

Robertson was responsible for the maintenance of this track circuit, and he said that no question of its failure then arose. It is clear from his cross-examination that he formed the impression from the conversation which he then had with Sneddon that, though Sneddon did not suggest it in so many words, the Dundee train had propelled back on to the track circuit, after Sneddon's acceptance of the Edinburgh train at 4.32 p.m. Robertson appears to have retained this impression for some weeks after the accident, until he heard the allegation that the track circuit itself had failed and that his maintenance was criticised by Sneddon; indeed, as it seems that he had only *" heard since that there was a possibility that the Dundee train had not moved back on to the track circuit,"* he did not make the foregoing statement until as late as 22nd January.

Telegraph Lineman A. Dickson arrived at Castlecary with Robertson, but went straight to the site of the accident, and was joined there a little later by Robertson after the latter's conversation which is referred to above. Dickson said that Robertson did not then refer to that conversation, but merely said, *" Everything is all right with me,"* meaning that the equipment for which Robertson was responsible, viz. track circuit, block instruments, etc., was in order. Dickson himself also went to the box to use the telephone between 9.30 and 10.0 p.m., and found Signalmen McLeod, Sneddon, and N. Marr there. He stated that he heard Marr say to Sneddon, *" What has happened here, Andrew?,"* and Sneddon replied, *" The Dundee came barging through my signals and when I looked up I saw the track (indicator) clear. I took on the* 4.3 *and when I looked up again the track (indicator) was occupied. I waved a red lamp and flew downstairs with detonators."* Dickson apparently gained the impression

from what he thus heard that *" the track circuit was working all right, and that was all I was concerned about."* He did not, however, then hear Sneddon suggest that the Dundee train had moved backwards after having come to a stand beyond the track circuit, though he thought that Sneddon *" realised that the track circuit was occupied before he left the cabin."*

Signalman Marr, on the other hand, when questioned with regard to this discussion, gave contrary evidence; he said that:—

" I asked him what had occurred, and he told me that the Dundee train had run through his sticks; I asked about the track (indicator), and he said that it showed clear, and then it passed through my mind that the train had passed off the track (circuit) and cleared him.

Then how did the collision take place on the track (circuit)?—I don't know.

Did you ask Signalman McLeod what he thought about it?—No, I can't remember asking him definitely.

Did you have any discussion with McLeod?—Yes, we discussed the thing all right.

What conclusion did you come to?—I could not exactly say what my impression was; several things turned up.

What were the several things?—Either the track (indicator) had failed or the man had make a mistake in saying the track (circuit) was clear. . . .

Did Sneddon refer to any witnesses?—Yes, he said the stationmaster was in the box.

When and in what circumstances?—Immediately before the collision took place. . . .

What did he suggest the stationmaster was a witness of?—The track (indicator) showing clear.

Did he suggest to you then that the stationmaster had seen the indicator was clear?—No, he didn't exactly say that. He said the stationmaster was in the box immediately before the accident took place, but he did not say that the stationmaster saw the track (indicator) clear in my hearing, as far as I can remember.

Then what impression did he leave in your mind with regard to the stationmaster?—Well, I understood him to mean that the stationmaster immediately left the box with detonators along with Sneddon to try to stop the 4.3.

At that time the track (indicator) being clear?—I understand that, yes."

While Sneddon had previously stated that he *" did not know until 7 o'clock on the night of the accident that the Dundee train was inside my starting signal,"* it will be noted from the foregoing accounts and evidence that at about 4.50 p.m. Scott had little doubt that Sneddon knew where the collision had taken place; further, it appears that Sneddon then suggested to Scott, as he had also just previously suggested to Beattie, that the Dundee train had moved back, and he evidently left the same impression in the minds of Robertson (5.45 p.m.), McLeod (8.0 p.m.), and Dickson (10.0 p.m.) that, as a result, he had seen the track indicator showing *occupied* before the collision, viz. before he left the box. The following extracts of Sneddon's subsequent cross-examination illustrate the contradictory nature of the evidence on these points:—

" Would you accept Beattie's statement that you told him (at 4.40 p.m.) that the train was at the platform?—It was the Edinburgh train I meant. I knew it was at the platform. . . . I did not know where the Dundee was at all, and, in view of the position of the Edinburgh, I could have formed the opinion right enough that it (the collision) was inside the starting signal; but I did not know definitely whether it was inside or outside.

You left the impression on Signalman Beattie (at 4.40 p.m.) that the accident was inside the starting signal?—I told him that the back end of the Edinburgh was at the platform.

Then how did you come to suggest that to him if you now suggest to me that you did not know where the accident was till 7 o'clock?—No, I really did not know until 7 o'clock that it was right inside. I did not know definitely. The stationmaster said he thought it was inside the starting signal. . . .

Do you remember your conversation with Lineman Robertson?—No, I do not remember. I remember speaking to him.

What did you tell Robertson?—He asked me how the accident happened, and I told him my track was clear when I accepted the Edinburgh.

And did you also say that after the acceptance the indicator showed occupied?—No, I never saw the indicator occupied for the Dundee train.

Nor after the acceptance of the Edinburgh train?—No, never saw it occupied.

You did not see it occupied before you left the cabin?—No.

And would you say that Robertson is untruthful if he made that statement?—Well, I don't remember saying that.

Did you tell Robertson about your conversation with Beattie?—No, not that I remember.

Did you suggest to Robertson that the track circuit had failed?—No. . . .

How did you think the accident happened?—My own mind was that the Dundee had set back. . . .

Did Stationmaster Scott suggest that to you when he came into the cabin?—No. . . . I told him when he came in—when he told me he thought it (the collision) was inside the starting signal—that my track was clear when I accepted the Edinburgh.

Would you contradict a statement by Signalman McLeod that you had stated that the indicator went to 'occupied' after you had accepted the train?—Well, when I knew definitely where the accident had occurred that was the only thing that I could assume, that the Dundee train had set back on my track (circuit); but to say that I saw the indicator go to 'track occupied' I certainly would contradict that, because I never did.

Then when did you first discuss with Stationmaster Scott this question of the train coming back?—When he came up to the box he told me the Dundee train wasn't there (i.e, site of collision) when he saw it. . . .

I take it you would accept Beattie's account?—Oh, yes.

That you first told Beattie 'It is on the platform'?—Yes, that was the tail lamp of the Edinburgh.

Did you not then realise where the Dundee was?—No, I didn't.

But surely you did?—No, I didn't.

But if you knew where the tail lamp of the Edinburgh was you would know where the collision was?—Yes, that is correct. I should have known, but I didn't.

Did you then suggest to Beattie that the Dundee had come back?—No. . .

Who first suggested that the train had come back; was it yoursell?—Yes, when the Stationmaster told me that it was there, it wasn't where the accident happened when he looked, and my track being clear, I couldn't assume any other thing.

That it emanated from the Stationmaster's suggestion that he saw the tail lamp of the Dundee train beyond the signal?—Yes, it wasn't there when he looked; it wasn't where the accident occurred when he looked. . . .

You say that after the Dundee train passed you saw the track indicator clear?—Yes.

When did you first see the track indicator in the occupied position?—After the accident.

Assuming that you told anyone that the track indicator showed occupied after your acceptance of the Edinburgh train, would that have meant after or before the collision?—. . . I would have meant after the collision. I never saw the indicator at occupied for the Dundee train.

Even if you had, assuming that you had said this, would the collision have been avoided?—Oh, no. . . .

Are you definite that you never saw the indicator occupied until after the collision?—Yes, very definite."

5. *The integrity of the track circuit, and/or of its indicator* is thus impugned by Signalman Sneddon's emphatic evidence that before the acceptance of the Edinburgh express, and while speaking to Beattie (who confirmed the conversation), the indicator was showing *"Clear."* Sneddon also referred to previous failures of the track circuit, and he generally criticised Telegraph Lineman Robertson's maintenance, accusing him of having falsely entered his name in the Lineman's Visiting Sheet. He stated, *"I have never signed that Lineman's Sheet for nearly two years, for the simple reason that he has not been attending to the electrical equipment in my opinion. . . . I got instructions from Stationmaster Brown, when he complained about the inattention that the electrical equipment was receiving, not to sign this man's sheet unless he was working at (or about) the place."* Sneddon also said that Robertson had been filling up the Track Circuit Record Card *"sometimes six months at a time. I am not going to be condemned on a track that is attended to in that way."*

On the other hand, Sneddon admitted that the track circuit was functioning properly up to, and during, the passage of the Cadder goods train, and extracts of cross-examination on the point are as follows:—

"You suggest, and it is a serious suggestion, that Robertson has been attending your box and signing your name?—Yes.

But at the same time I understand you have had no complaint of the operation of the track circuit?—No, with regard to the track circuit I can assure you I have no complaint, bar what I have told you. . . .

Do you consider that the neglect that you now allege is partly responsible for the failure of this track circuit?—Well, I am not going to accept any responsibility for it, because I protected myself, inasmuch as I never signed this man's Visiting Sheets, which indicated that I considered he was not giving it attention, and those were my instructions from Stationmaster Brown. . . .

When did it occur to you that the track circuit had failed?—Well, it never really occurred to me at all that the track circuit had failed. I couldn't say definitely that the track circuit had failed. . . .

Was it after the test that was made on the 15th December, after the Company's Inquiry?—No, I think that I said that if the Dundee train did not go past where the collision occurred, then the track (indicator) did not give me a proper indication, and I think I discussed about track circuits with Signalman Beattie on the Sunday (12th December) either coming back from or going to Edinburgh; I can't remember which, but that was the first time it did enter my mind that it was possible."

I need hardly say that this matter has been thoroughly investigated by Mr. Fraser, whose report and evidence, in brief, are as follows:—

"Stationmaster Brown indicated in his evidence that he had two block failures in one week. As a result of that I have made inquiries, and from my papers I have ascertained that

in May, 1935, three block failures occurred in Robertson's section, which were due to a faulty earth connection, a defective zinc, and a broken porous pot. Robertson's attention was called to these failures, and his section examined at that time, and he was informed that his maintenance would be kept under close observation. The examination referred to as being made in Robertson's section in May, 1935, was carried out by a special squad. Since that date no cause of complaint has been found with Robertson's maintenance. Following this accident a careful examination has again been made of Robertson's section by Mr. Moss' chief assistant, Mr. Alexander, and Inspector Murray, of the district, and they have reported that Robertson has carried out his maintenance duties in a satisfactory manner, but that the general tidiness of the section might be improved. . . .

It is the position now that, so far as Robertson's maintenance is concerned at the moment, I have nothing adverse to say about it, other than the tidiness of it, but, of course, he has still to be dealt with in regard to the occasions on which he put the signalmen's names on to sheets without their authority or knowledge.

Q. I take it you are satisfied that this is not a case of Robertson filling in forms to show that he was present at Castlecary, maintaining, when he was not doing so?—No. I have gone over the records for 1937 and in every case where Signalman Sneddon's name has been signed on the form Robertson has also signed the Record or Register Book, except in one case; and Robertson previously gave me an explanation in regard to that, that it was just possible he did not go near the cabin as probably he was working outside, against time, and that he probably had to catch a train to take him to another part of the section."

With regard to the track circuit in question, its history can be considered as good. Since January, 1934, viz. for nearly four years, the Traffic Department had had no occasion to complain of unsatisfactory operation, and since its installation in 1921 no danger-side failure had been reported. Mr. Fraser's review of its history and of the allegations made by Signalman Sneddon is as follows:—

" Prior to 1933 this track circuit was under the maintenance of the Electrical Engineer's Department, and Telegraph Lineman Robertson, who has been there since 1923, had only had occasion to report two safety-side failures during that period. After April, 1933, the maintenance of all track circuits and electrical signalling equipment was transferred to the Engineer's Department. Records of the behaviour of such apparatus have been regularly kept, and reference to these records shows that only one failure of this particular track circuit has been reported since 1933. This was also a safety-side failure, which occurred on the 10th January, 1934, and was due to a disconnection of a line wire at the top of a terminal pole at the relay end of the track. The failure was intermittent in character, rectifying itself before the lineman's arrival and not failing again prior to being permanently repaired.

During the Inquiry it transpired that Signalman Marr had made an entry in the train register book under date of 17th April, 1937, to the effect that the track circuit failed from 3.17 p.m. to 3.18 p.m. The occasion was the passage of the 2.48 p.m. stopping train Alloa to Glasgow and when this train, after stopping in the station, cleared the track circuit the indicator did not show ' clear ' until one minute had elapsed. Signalman Marr did not report this occurrence to his own Department, neither did he mention it to the lineman until after a week or ten days had passed. This alleged failure was a safety-side one, and, owing to its short duration, may be accounted for by the sluggish operation of the track relay, due either to low ballast resistance consequent upon a shower of rain, or to a prolonged occupation of the track circuit by the train standing in the station and consequent short circuiting of the battery, which prevented the latter from building up its normal voltage immediately the short circuit was removed.

Signalman Sneddon also made reference to an occasion when he alleged that the track indicator failed on the danger side, as it remained in the ' track clear ' position and had to be knocked before it assumed the ' track occupied ' position. He had no clear idea as to when this failure took place, but thought it was during the time Mr. McVarish was station-master, some 4½ to 5 years ago. He further stated that Telegraph Lineman Robertson took the indicator to pieces and that Signal Lineman Sinton was present at the time. He did not record the occurrance in the Train Register Book or report it to anyone. On the other hand, Robertson said that he could not remember having to tap the indicator, and whilst he might have taken it down and removed the cover for examination purposes, he had no definite recollection of having specially done so, probably due to the fact that such work falls under normal routine duties.

Signal Lineman Sinton said he remembered an occasion, perhaps some four or five years ago, when he was working at Castlecary; upon going into the signal box he observed that Telegraph Lineman Robertson had the track circuit indicator disconnected and was examining the bearings. He said that, being interested, he also had a look at it, and, when it was replaced, he noticed that it operated correctly when the track circuit outside was occupied. He attached no special importance to the incident, as he considered that Lineman Robertson was carrying out his ordinary routine work. Robertson, however, made reference to another occasion when some doubt arose with the signalman as to whether a vehicle was occupying this track circuit during shunting operations. He requested Signalman Preston particularly to watch the track indicator during a similar operation the following week, but no trouble was experienced. Signal Lineman Sinton, who was apparently in the box at the time, remembered something of the sort taking place, but that it was on a subsequent occasion to the incident referred to above.

Summary.—Since 1921 three safety-side failures have been reported:—One due to flooding, and one to freezing of bluestone cells, prior to 1933; one due to an intermittent disconnection of an insulated wire at the terminal pole, on 10th January, 1934.

Owing to its short duration—one minute—Signalman Marr's reference to an unreported failure on 17th April, 1937, is of little consequence beyond indicating a slightly abnormal condition. There is always a time lag between the clearing of a track circuit and the operation in sequence of the track relay and indicator. Whilst normally this is infinitesimal, it is more pronounced where primary batteries are used and where the capacity of the cells is nearing exhaustion. Signalman Sneddon's reference to an unreported danger-side failure some 4½ to 5 years ago is very vague, and there is considerable doubt as to the conditions appertaining to such a failure ever being present."

With regard to the indicator itself, which had also been in service since 1921, no likely cause of danger-side failure was found after special examination and test in the Company's instrument repair shop, and the following results were reported:—The bearings, which are jewelled, showed no signs of wear on the pivots. There were no signs of moisture having been present on the pivots, and the complete axle was in good condition. The movement was of Spagnoletti type, and there was ample clearance between the coil windings and the movement. The banner was made of sheet aluminium, and the edges, where they touched the buffer spring stops, were not indented; the ivorine buffer stops were in good condition, and the surface was not grooved or marked in any way. On test, the indicator operated freely at the normal current of 1·5 m.a., and when given excess current of 6 m.a., the banner showed no tendency to stick in the *Clear* position when current was interrupted.

With regard generally to the 1,024 track circuits in the Scottish Area, the records for 1937 show that there were only six danger-side false-clear failures; three were due to heavily sanded rails, one to a broken jumper wire on a parallel portion of the track circuit, and the other two were not definitely established.

The causes of ordinary safety-side failures for 1937 are as follows:—

Excessive leakage (due to the wet conditions experienced in Scotland and in some cases to sea spraying the track)	76
Broken bond wires or leads	82
Faulty insulated fishplates or rods	34
Miscellaneous causes	38
Causes unknown	41
Total	271

This gives an approximate incidence of safety-side failure of one in every four years per track circuit.

X.—Conclusion.

1. This Inquiry was rendered difficult by the scope and contradictory nature of the evidence (910 pages), and the proceedings covered seven days, the last on 24th March; certain aspects of the evidence were also very unsatisfactory, and I doubt whether all the facts in detail will ever be fully established. I am unable, therefore, to arrive at such definite conclusions as I should have wished.

The main feature of the case was Signalman Sneddon's grave mistake in permitting the Edinburgh express to approach Castlecary under full *Line-Clear*, after having assumed, merely two minutes previously (according to his own account), that he had failed to stop the Dundee express, and that it was then about to collide with the goods train standing ahead at Dullatur.

It is difficult to believe that a responsible signalman could do such a thing, still less to plead justification because Block Telegraph Regulations do not prohibit such action in the circumstances which he alleged. Indeed, doubt naturally arises with regard to the integrity of the evidence relating not only to the operation of the goods train in the first place, but to the subsequent acceptance of the Dundee train, and to the circumstances in which Sneddon found it necessary to stop the latter.

Prima facie there was also human failure on the part of both Drivers D. Macaulay and D. Anderson; but the other features of the case, which made it so complicated, were the allegations that failure in equipment directly contributed to the disaster. First, that Sneddon was deceived at 4.32 p.m. (before he accepted the Edinburgh express) by a false-clear indication of his track circuit indicator; secondly, that both drivers were deceived while running at high speed by the display of a false-clear aspect of the distant signal.

These allegations regarding equipment have two points in common, namely, (*a*) that two entirely different kinds of apparatus, one electrical and the other mechanical, failed *simultaneously* on the danger side, although (*b*) Signalman Sneddon had had no cause for complaint in respect of either while he was operating the previous eight down trains, since coming on duty at 2.0 p.m., and during the worst of the snowstorm. The extraordinary coincidence of two such failures occurring at this particular moment makes either seem highly improbable; but there is little doubt, as is shown by the statistics, that the very rare false-clear indication of a track circuit indicator is much less likely than the false-clear indication of a distant signal, particularly during weather conditions such as prevailed on this occasion.

2. *Alleged False-Clear Failure of the Track Circuit.* Sneddon's justification for his action in accepting the Edinburgh express was based upon his statement that he viewed the indicator showing *Clear* from his position at the telephone while actually speaking to Signalman Beattie, who confirmed the fact that discussion on the subject (probably two conversations) took place. I am satisfied that Beattie's evidence can be relied upon, and his account, on the face of it, provided confirmation with regard to the careful consideration which Sneddon said he gave to all his actions, an aspect which he was at some pains to emphasise throughout his evidence.

In fact, on the ground which Sneddon stressed, viz., that it was unlikely that he would have deceived his colleague Beattie, he first suggested, with the support of Stationmaster Scott, that, assuming the track circuit indicator was in order, the Dundee train came to a stand beyond the track circuit and was subsequently propelled back to the site of the collision; but, later, when it was realised that the evidence and practical demonstration made this suggestion unacceptable, Sneddon pursued the serious allegations that the track circuit was not being properly maintained, and that it, and/or its indicator, must have failed on the danger side.

The case against the track circuit rests, therefore, entirely upon Sneddon's word, and the whole motive of his allegations, both with regard to the maintenance of the equipment and to the indicator deceiving him, would have fallen to the ground had the collision taken place, as it certainly would have, clear of the track circuit, 18 yds. ahead of the starting signal, instead of 156 yds. in rear of it. But he would then have been able definitely to claim protection from criticism for having disobeyed Block Telegraph Regulations.

He was in the signal box for six hours after the accident, and at different times during this long period was questioned by a number of people with regard to the circumstances. It seems clear that any serious suggestion of danger-side failure was not then uppermost in anyone's mind, and, on the basis of Sneddon's account, the above-mentioned idea apparently gained credence, viz., that the Dundee train, before propelling back to the site of the collision, must have come to a stand "*through*" the starting signal and clear of the track circuit, instead of "*at*" the starting signal (as stated by Fireman Fleming when he reached the box) and occupying the track circuit.

This suggestion was also supported by Stationmaster Scott's alleged impression, as the result of observation at about 4.31 p.m., when he was returning from the brickworks, that he saw the tail light of the Dundee train "*quite plainly, just beyond the starting signal.*" As it was twilight, however, and he was looking westwards towards the sunset and the rear of the lighted passenger train, which was standing on a curve in a snow-covered cutting, I find it extremely difficult to believe that this very erroneous idea of Scott's was not put forward merely to assist in relieving Sneddon of responsibility; the tail light was 145 yds. from Scott's office (and only 33 yds. beyond the west end of the platform), while he alleged that he thought it was double the distance away, namely, "*just beyond*" the starting signal, distant 300 yds.

But with the further support, for what it was worth, of the lad Macdougall, who has only a few months' service, Scott's suggestion was sufficient to prevent this idea being altogether discarded at the Company's Inquiry on the 12th December, despite the definite evidence of Fireman Fleming and Guard Inglis with regard to the position of the train, and notwithstanding Foreman Cunningham's report of the 11th December forwarding Driver Macaulay's statement that he "*brought the Dundee train to a stand AT the advance signal.*"

In fact, Sneddon's allegation that the track circuit indicator showed *Clear* at 4.32 p.m. is the ground on which he sought to justify his acceptance of the Edinburgh train, and to relieve himself of the responsibility for having specifically infringed Block Telegraph Regulations. But I am inclined to think that the impressions which Telegraph Lineman Robertson (5.45 p.m.), Signalman McLeod (8.0 p.m.), and Telegraph Lineman Dickson (10.0 p.m.) gained from his subsequent conversations and explanations, were probably correct, viz., that Sneddon *did* see the indicator in the *Occupied* position before he left the box, though he would not admit it, and that this is how he was accounting *that evening* for his assurance to Beattie, and for his acceptance of the train, although the site of the collision was actually on the track circuit.

While Sneddon also affirmed that he did not even hear the sound of the collision, distant only 294 yds., he was further prepared at first to mislead me by saying that he did not know until 7.0 p.m. (subsequently qualified by "*know definitely*") where the collision took place, though he cannot have avoided realising by his own observation that the rear coach of the Edinburgh train was actually standing at the platform, distant only 240 yds. (compared with the starting signal, distant 450 yds). Indeed, he subsequently admitted that, so far as the occupation or otherwise of the track circuit was concerned, he was sufficiently aware of the location by 4.50 p.m., when Scott came back to the box and advised him; further, when Guard Cameron walked back to protect the Edinburgh train, he can hardly have failed to inform Sneddon on the point. I think there is also no doubt that when Sneddon spoke to Beattie at 4.40 p.m. (to obtain the times of the Edinburgh train, and that of the *Out-of-Section* for the Dundee train, to enter them up in his register), he must have been fully aware that the collision had taken place *on* the track circuit, and that he definitely left the idea in Beattie's mind that the Dundee train had moved back.

But Sneddon evidently felt uncertain about the acceptability of this suggestion, and, on the 12th December, either before or after the Company's Inquiry, he appears to have discussed with Beattie the possibility, and incidence, of danger-side failures of track circuits. I understand also that the issue was made quite clear to him at this Inquiry. When, therefore, test on the 15th December with a train, similar in composition to the Dundee express, proved that it could be pulled up in 478 yds. from 58 m.p.h., as compared with Driver Macaulay's stop of 468 yds., and when the evidence at my Inquiry subsequently made it incontestibly clear that the Dundee train had come to a stand *at*, and had not moved from, the position in which the collision took place, the only alternative left to Sneddon was to pursue the allegation of danger-side failure of the track circuit and/or its indicator, if he was not prepared to admit having misled Beattie about the position of the indicator, and to accept responsibility for infringing Block Telegraph Regulations with regard to the acceptance of the Edinburgh train.

Sneddon persisted, however, in his serious allegation, which he knew could not be refuted definitely, but which he thought, until my Inquiry, might receive support from Scott; he went still further in suggesting that the track circuit was not being adequately maintained and that Telegraph Lineman Robertson was forging his signature on the weekly time sheets. Robertson's prompt and frank admission of the latter was to his credit; but it is an aspect of this case which will no doubt be dealt with appropriately by the Company's Engineer. I am satisfied, however, as he is, that the suggestion that Robertson had not been attending to his maintenance duties was unjustified.

With regard to the main allegation, there was the misunderstanding between Sneddon and Scott, in contrast with the impressions gained by Robertson, McLeod, and Dickson. On the one hand, Sneddon suggested that Scott had actually told him that he saw the indicator showing *Clear* when he came to the

box before the collision; on the other hand, Scott strenuously denied that, and would not support Sneddon further than the suggestion already mentioned, viz., that the Dundee train had come to a stand "*through*" the starting signal and beyond the track circuit.

Again, Sneddon denied Fleming's account in that respect, though Fleming, who appeared to be a truthful witness and had no reason to be otherwise, obviously knew the position of the Dundee train, for which he was reporting; there seems to be little doubt that Fleming's assumption was correct, viz., that both Sneddon and Scott heard what he said and that *both* understood at that time where the Dundee express was actually standing, viz., *at* the starting signal and therefore occupying the track circuit. Indeed, Scott admitted that he went to the window then and viewed the tail light, distant only 294 yds. It is difficult to believe that Scott, and certainly Sneddon, did not *then* look at the indicator and realise that it showed *Occupied,* as Robertson, McLeod, and Dickson assumed was the case from Sneddon's later explanations. As I have said, however, Sneddon would not admit that, and Scott's evidence was mainly directed to show how little he knew of the circumstances; indeed, he suggested that he was in the box for merely four seconds (timed), though such a period was too brief to cover even the act of going to the front window, not to mention looking out of it and viewing the tail light.

I was profoundly dissatisfied with the uncertain and contradictory accounts of what happened in the box at this time, and, having regard to Scott's admission that little more than the length of the staircase separated him from Fleming when the latter arrived, I feel I cannot accept his evidence that he heard nothing of the conversation between Fleming and Sneddon. Further, no-one could, or would, explain how, or why, the last figure of the time, 4.35 p.m., which Fleming had entered in the register, was nearly obliterated by what is apparently a superimposed 8; also his estimate of nearly two minutes (timed), rough as that may be, of the period which elapsed between his entry into the box and the passage of the Edinburgh express, compared with Scott's briefer, and more unlikely, estimate of 45 seconds.

Assuming that Beattie had transmitted the *Entering-Section* signal at 4.36 p.m., as he said, and if the collision took place at 4.37½ p.m., Scott's estimate should have been nearer 90 seconds, even if, as he affirmed, he reached the box so late as 4.36 p.m., viz., just before this signal was received. On the other hand, notwithstanding this comparatively long period of time which must have been available for action, the three men "*rushed*" out of the box and down the stairs, Scott having time only to utter the one word "*Detonators*"; Sneddon also was able to fix only one detonator properly on the rail at, he suggested, a point "30 *to* 50 *yds.*" beyond the home signal at the west end of the viaduct. Contrary to his carefully worded statement (quoted on page 31) which was prepared and signed at the Inquiry on the 12th, he admitted that he did *not* in fact "*run across*" the viaduct. If it was also true that Sneddon had thought it necessary at all, and intended, to lay detonators, as he affirmed, he had had the much longer previous period, 4.32 p.m. till 4.36 p.m., in which to act; I am not surprised that Fleming criticised his failure in this respect, and it makes me wonder whether Sneddon had even thought of the necessity for it.

It seems, therefore, that on this point also little reliance can be placed upon either Sneddon's or Scott's accounts, and I think it may reasonably be assumed that probably more time was taken up by discussion in the box than they represented, and that the placing of the detonators may actually have been an afterthought, instigated by Fleming's arrival, by his information as to the position of the Dundee express, and by his remark with regard to lack of action; also perhaps by the result of observation of the track indicator showing *Occupied,* and finally even by realisation that the Edinburgh express was actually passing the distant signal and was about to repeat what had just previously happened. It is difficult, otherwise, to account for the feeling which appears to have existed in their minds that this train also would inevitably fail to obey signals.

With regard to what happened during the period after 4.32 p.m. until Fleming's and Scott's arrival, three or four minutes later, Sneddon said that he tried twice, without success however, to report the runaway to Control; he had also to handle the 4.6 p.m. up passenger train ex Glasgow which passed at 4.33 p.m., *Out-Of-Section* being received from Beattie at 4.35 p.m., Sneddon

stated that he entered these times, and others for this train, in his Register, though he admitted that he had not previously made the earlier entry at 4.32 p.m., on the opposite side of the book, for the *Out-Of-Section* signal for the Dundee train and for the acceptance of the Edinburgh train. Further, in explaining how he employed his time, and why he did not observe his track indicator again during this long period, he could remember "*having a look at Regulation 23 regarding the acceptance of the following train*"; he also suggested that (besides the brief telephone conversation in calling Scott to the box) he *might* have been engaged on the telephone with other calls.

The foregoing thus indicates the nature of the case, and the circumstances attending the allegations, against the track circuit, viz., how and why Sneddon, according to his account, appears to have been deceived at 4.32 p.m. into accepting the Edinburgh express. He stated that he saw the indicator working properly up to and including the passage of the Cadder goods train at 4.9 p.m.; but, though he took special action and displayed a red lamp to stop the Dundee express, at 4.29½ p.m., he failed to look at the instrument (in accordance with Appendix Instruction 01) when he returned to his frame as the rear of the train was passing the middle of the platform; nor did he look at the instrument while then sending the 4-5-5 bell-signal to Smith, which was admittedly transmitted before Sneddon expected the train to have passed the down starting signal. He could not explain this omission, and he also failed to look at the indicator when speaking on the telephone to Macdougall and later to Scott; yet, he alleged that, at the intervening moment, 4.32 p.m., when speaking to Beattie, he "*very keenly*" observed it at *Clear*, viz., the position in which he *expected* it to be, in view of his erroneous assumption that he had failed to stop the Dundee train.

Thereafter, however, during the next four minutes, in spite of the unprecedented circumstances, he "*could not remember*" looking at the indicator again, and, for the same reason, however illogical, his suggestion was that even had he done so, a *Clear* indication would have had no significance to him. To have admitted, however, that it showed *Occupied*, during this time, would have been tantamount to withdrawing the allegation that he had been deceived by the failure of the track circuit, and would have involved the criticism that he took no last-minute action to stop the entry into the section of the Edinburgh express. Nor, for the latter reason, presumably, would he admit it, even after Fleming's arrival in the box with information as to where the Dundee train was actually standing.

Altogether, Sneddon's account was unconvincing, and his case against the track circuit and/or its indicator was of the flimsiest nature, depending entirely upon his word. Apart also from the impression which he afterwards left in the minds of the three men referred to—two of whom, Signalman McLeod and Telegraph Lineman Dickson, were not involved in any way—that he (Sneddon) actually saw the indicator showing *Occupied, after* his acceptance of the Edinburgh express and *before* he left the box, there is the fact that it was admittedly in this position when he returned to the box.

Added to that, the track circuit operated satisfactorily, without work or adjustment of any kind, when the permanent-way had been relaid and the necessary bonding had been completed. The indicator also functioned properly after this work had been carried out, and special examination and test disclosed no likely cause for danger-side failure. Notwithstanding, therefore, the lack of definite proof that this equipment operated properly between the material times 4.29½ p.m. and 4.37½ p.m., I attach so little value to Sneddon's explanations of this matter that, of all the contradictory features in this case, I have the least hesitation about forming the opinion that neither the track circuit, nor its indicator, failed as he alleged. Indeed, it seems very questionable whether he should be given the benefit of any doubt which may remain on the subject, and the only extenuating circumstance is the fact that, although 458 yds. away, Driver Macaulay unfortunately omitted to whistle when the Dundee train came to a stand.

Sneddon, however, neither attempted to ascertain if he had attracted Macaulay's attention, nor whether he had prevented the train from running away, notwithstanding his unusual display of the red hand signal, action which he had not previously had to take in the whole of his six years' experience at

Castlecary. If, in the exceptional circumstances, he had subsequently made the slightest effort, during the period between 4.32 p.m. and 4.36 p.m., either to go to the front window to look out of the box or to telephone to Signalman Smith at Dullatur, and to interest himself in what had happened to the train—if it be true that he really expected it to collide with the goods train during this time—he would presumably have taken action to prevent the approach of the Edinburgh express.

Indeed, there is no adequate excuse for Sneddon's failure in these respects, and it appears that he was chiefly concerning himself with sharing his responsibility with Beattie—who "*didn't persuade*" him—with a view to ensuring a "*reasonable excuse for delaying*" the Edinburgh train, which, however, would in any case have had to be stopped at Greenhill Junction had the Dundee train stopped at Castlecary home signal.

Sneddon has a clear record and was well spoken of; his officers looked upon him as a conscientious and reliable signalman. It appeared to me, however, that his outlook was limited by the Rules and Regulations, and that he had an acute mind in this respect. As a theorist rather than a practical signalman, evidently he could not be depended upon in an emergency in such a responsible position as a main line signal box. His age is 35, and he has 15 years' service, of which the last 13 have been spent in his present capacity.

It seems surprising that such an experienced signalman as Beattie should have acquiesced in the acceptance of the Edinburgh express, but, having heard his evidence and what transpired, I feel that the accident would not have happened had he been in charge at Castlecary. He is 50 years of age, and has been a signalman for 33 years.

With regard to Signalman Smith of Dullatur, it seems that Sneddon wished to avoid consulting him for some reason, and turned in preference to Beattie. In comparison, Smith, an older man, is of slower perception; but his evidence, which seemed trustworthy, appeared to dispose of any suggestion that the goods train had been "*forgotten*", or that Sneddon had received a last-minute reminder of its presence. It is true that Sneddon did not know its position before 4.22 p.m., when he accepted the Dundee train, as he had taken no action to ascertain why the *Out-of-Section* signal for it had not been transmitted by Smith after 4.14 p.m., the time when the train would normally have been expected to pass Dullatur; but both Sneddon and Smith strongly denied that the Dundee train had been offered and accepted in error, while the former also denied that his signals had been wrongly lowered for it.

With regard to Fireman Fleming, he appears to have lost no time in traversing the 458 yards from his engine to the box in five or six minutes, and, in the circumstances, I feel that his account of what transpired is more credible than that of either Signalman Sneddon or Stationmaster Scott. Unfortunately, he appears to have been just too late to have the Edinburgh express stopped before it entered the section.

Had Stationmaster Scott also realised the position earlier when speaking to Sneddon on the telephone, the latter might have had time to rectify his mistake. Apparently it took Scott at least four minutes to run from the east end of the up platform to his office (when he viewed the tail light of the Dundee train) to telephone to Sneddon, and to run back to the box, a total distance of under 200 yards. However, I do not suggest that any blame attaches to him in this matter; I was informed by his officers that he is a capable stationmaster and his services were highly spoken of in connection with organising the subsequent relief work, etc.

3. *Alleged False-Clear Aspect of the Down Distant Signal.*—This is admittedly a more likely occurrence than the danger-side failure of the track circuit; it is a condition which brought about a collision with the gates at Greenlaw Public Road Level Crossing at 10.4 a.m. on the 10th December, and it is one dealt with in reports upon accidents in the past. It is specially referred to in Appendix Instruction (h2), already quoted.

There is no suggestion of sabotage or interference with the equipment, either before or after the accident; Ganger Bell, who, with his men, passed the distant

signal when walking down the line, provided evidence that it was then at *Caution*, although his sense of observation (e.g., of the weather and of passing trains) appeared to be quite unreliable. But, subsequently, No. 1446 special goods train passed at 3.40 p.m, and the 3.41 p.m. down passenger train, Polmont to Glasgow, stopped at the station at 3.59 p.m., the signal having remained in its clear position, according to the bookings, for about four and two minutes respectively. According to his evidence, Sneddon lowered the signal for the last time for the Cadder goods train, and he affirmed that after its passage at 4.9 p.m. he saw the arm return to its *Caution* position and respond properly to the lever, it having remained in its clear position for, say, four minutes since the acceptance of the train by Dullatur East at 4.5 p.m. He stated that *" I could see my distant plainly going back to danger. . . . If I had not seen it I would not be so positive"*. In addition to this, there is Sneddon's statement that he observed the backlight of the signal at 4.22 p.m. when he accepted the Dundee express and when *" it was slight snow at that time"*.

The signal, however, was not repeated in the box, and, as already stated, I feel, after considering the evidence of 34 witnesses, including Sneddon, and having regard to my own observations, that, although the worst of the snow may have passed, it is very doubtful whether visibility, in the failing light between 4.0 p.m. and 5.0 p.m., extended much beyond, say, 400 to 500 yards. Notwithstanding such support as was afforded by Stationmaster Scott and Signalmen Beattie and McLeod, I consider that Sneddon's view of this backlight, which was 777 yards away, must have been very problematical on the evening in question, even assuming that he did look for it from outside the front window, and not through the snow-covered windows on the east side of his box.

Moreover, the fact that the lamp in the box was alight (since 3.45 p.m.) cannot have facilitated his observation under the prevailing conditions, and it is unlikely that Sneddon's word is to be trusted more in this respect than with regard to the track circuit indicator. On the other hand, assuming that he *was* able to see the backlight, it has also to be borne in mind that the full light could have been displayed with the arm at an angle of 16°, while the light could not have been completely obscured unless the *droop* of the arm assumed as much as 29½°, although it is doubtful whether, in practice, the light would have been observable with the arm much lower than, say, 25°.

In these circumstances, the integrity of the evidence of the two drivers concerned is of great importance; but, unfortunately, neither had the support of his fireman. I was impressed, however, with the sincerity and confidence of both men. Driver D. Macaulay of the Dundee express is 60 years of age, with 41 years' service and an excellent record; his back was severely injured, and he was only sufficiently recovered by the 21st January to give evidence at Thornton Shed, near his home. Driver D. Anderson, of the Edinburgh express, is 42 years of age, with 25 years' service. He had on the whole a very good record, and had been a driver for 17 years; he was one of the senior spare drivers at Haymarket, fully qualified to handle all important main line services working into and out of Edinburgh. He had worked the Edinburgh express on the previous Monday, Wednesday and Thursday of the week.

Macaulay was evidently on the alert, for he observed the red light being waved from the box, and he made a very rapid stop. Similarly, Fireman Kinnear confirmed the fact that Anderson acted promptly on seeing the red light on the ground, and on hearing the detonator. Neither driver suggested that he saw the home signal, and each said that the reason why he applied the brake was his observation of the red lamp.

The important point which arises with regard to their evidence is the range within which (and therefore the time during which) they said that they observed the distant signal arm; neither of them saw its light, neither of them whistled. Macaulay estimated this distance as 150 yards, and by test with a model, he suggested that the arm was fully clear at 31° to 32° from the horizontal. Anderson, travelling at higher speed, said he made his observation at no more than 50 to 100 yards (and also by looking back), and judged that the arm was about 37° from the horizontal. *" It may have been more; I would not swear to it, but I know it was fairly well off"*. If Macaulay's estimate was right,

however, Anderson's must be wrong, as the signal cannot have increased its angle from the horizontal except by weight of snow, which was most unlikely during the seven or eight minutes interval between the two trains.

On the other hand, Macaulay's conversations with Fireman Fleming and Guard Inglis, his subsequent visit to the box, and his conversation with Signalman Sneddon, make it appear doubtful whether he was, in fact, really satisfied that the signal was not at *caution*, or at any rate only *drooping* to the extent that he should not have accepted it, as he did, as *clear*. Indeed, there seems to be some reason for Signalman Sneddon's suggestion that Macaulay, being so severely injured, merely dragged himself to the box to *" make sure I had no repeater "* before he asked about the aspect of the signal; *" my opinion was that he was going to blame the signal; that because I had no repeater he would be thinking that I did not know whether my signal was at danger or off "*. Sneddon also contradicted Macaulay's statement that he inquired the time; again, Telegraph Lineman Robertson's account supports Sneddon, but, contrary to the evidence of the other three men, suggests that Macaulay referred to the signal as being *clear* instead of *drooping*.

As to Anderson's evidence, it can also be said that, having regard to the height of the signal, and his limited view, the *droop* which Macaulay is said to have observed might well have mistakenly appeared lower to Anderson, and in his favour it should be recorded that he made no attempt to exaggerate the length of his view, to avoid the criticism that speed was too high for reliable observation under the prevailing conditions. He is also entitled to the credit that up to Greenhill Junction inclusive (where he judged that visibility was 300 to 400 yards) he appears generally to have been experiencing better conditions than obtained at Castlecary.

Further, there is the unusual feature in this case that the word of the signalman is contradicted by the two drivers, who in turn, and in good faith, accepted the signal as *clear*, not *drooping*. Neither Sneddon nor Scott even tried to view the backlight after the accident, and the presumption in favour of the drivers is stronger still when the gravest doubt exists as to whether the signal was within Sneddon's view at all.

The signal, however, was undoubtedly at *Caution* an hour later, at 5.39 p.m. (when the light engine passed it), as it had been at 3.35 p.m.; and if it had remained in a position below the horizontal for the two expresses, it means that vibration (which I noted was caused to some extent in the post) must have been insufficient during the passage of the lighter and slower train, but sufficient during the passage of the heavier and faster train, to have permitted the counterweight to do its work and return the arm to normal by overcoming the presumed resistance due to frost.

In all the circumstances, therefore, I regret that I am unable to conclude definitely whether the signal was at *Caution*, *drooping*, or *falsely-clear*, and in the absence of proof, I do not think anyone will be able to do more than offer an opinion. On the whole, I feel that the probabilities are against a danger-side failure, as it was a particularly easy-working signal, it was satisfactorily maintained (except for the adjustment of the back-light blinder), it had a straight run of wire, the additional resistance due to contact with the boards on the bridge was probably negligible, temperature was little below freezing, and Sneddon should have realised, even by feel, if the signal was not working properly.

Further, having regard to speed, there must remain the suspicion that neither driver had sufficient time properly to view the signal, and that once Greenhill Junction was passed under clear signals attention might have been relaxed, particularly at an unimportant station like Castlecary; again, so far as Anderson was concerned, he received a clear distant at Redding and might reasonably have assumed that the Dundee train ahead, which had made its last stop at Falkirk, was on time, and he would therefore have been normally anticipating a clear road ahead. Moreover, he had not had adverse signals here for many months.

On the other hand, as proof that Anderson was a careful driver and took notice of incorrectly displayed, or drooping, distant signals, his reference to, and action in connection with, the defective upper quadrant signal at Polmont, on

the previous day, is significant. Though visibility was better on the 9th December than on the 10th, this signal was definitely affected by frost under much the same temperature conditions. There is also the incident with the Castlecary distant signal on the 6th December (under considerably lower temperature), of which Signalman Sneddon said he was not aware. Further, there is the quite exceptional circumstance in this case that these two experienced drivers, separated by only seven or eight minutes, confirmed each other's evidence and observation of the same signal; finally, so little reliance can be placed upon the evidence of Sneddon and Scott with regard to range of visibility at the time in question that it would be unfair to hold definitely that the signal was properly at *Caution*. I feel, therefore, that, in the absence of proof, it cannot but be reasonable to conclude that both Macaulay and Anderson should be given the benefit of the doubt.

It remains to consider the extent of their responsibilities. As I have said, it cannot be suggested that they were not on the alert; but it was snowing in large flakes, and conditions of visibility were obviously difficult. Semaphore arms were covered with snow, and lights, at any rate that of the distant signal in question, were not observable except at close range. The question at issue is whether a driver is justified in maintaining normal speed under such abnormal conditions. I do not think that either driver in this case can have been really complying with the spirit of Rule 127 (iv) as strictly as appears to be intended. High speed clearly militates against reliable observation of signals when range of visibility is poor and the signals themselves are indistinct; my attention was particularly drawn to the handling of the Edinburgh train in this respect.

I find it difficult, therefore, to relieve Driver Anderson of the responsibility of permitting himself to incur a measure of unnecessary risk in his approach to Castlecary; he had covered the 31¾ miles from Edinburgh in 34½ minutes, and although he passed Polmont at least one minute late, distance 9½ miles, Castlecary was apparently reached on time. But it must be recognised that he was aware of his location, and was perhaps deceived in respect of range of visibility by the better display of the electrically-lighted signals at Greenhill Junction. While I know that there is considerable pressure to-day to maintain time, it would not appear to be exerted to the extent of criticism for late running in adverse weather conditions; had, for instance, Anderson been travelling at 40 to 50 m.p.h. instead of perhaps 70 m.p.h., the red hand lamp and detonator warnings, distant, say, 350 yards from the obstruction, might have been the means of preventing the collision, or at least greatly mitigating its results.

With regard to Driver Macaulay, he made a good stop, and very promptly sent his fireman back to the box to ascertain what was wrong, even though he had come to a stand on the track circuit in rear of the starting signal. But I think that, in all the circumstances, he should have intimated his position by whistle, in accordance with Rule 55 (*a*), and he cannot be relieved of some responsibility in this respect. Assuming that Signalman Sneddon would have heard it (458 yards away to the west, with an east wind) and would have acted upon the warning thus received, the accident should thereby have been prevented.

XI.—Summary.

The circumstances of this regrettable accident were quite exceptional, combined with bad weather conditions which involved low visibility. Failure properly to clear snow from points at Gartshore, 5¼ miles ahead, reacted on down traffic until the time came for action in respect of the two expresses concerned. That action unfortunately failed, but even then I think it may fairly be said, as confirming the high standard of safety which is normally maintained, that three men had to participate in varying degrees before the collision took place, viz., primarily, Signalman A. Sneddon, and, to a lesser extent, Drivers D. Macaulay and D. Anderson.

Although it was snowing less heavily after 4.0 p.m., it appears most unlikely, contrary to his evidence, that Signalman Sneddon was able to see the arm of the distant signal at 4.9 p.m., still less its backlight at 4.22 p.m. and 4.32 p.m., the times at which he accepted the two expresses. The evidence of Mr. G. S. Inglis, the Company's Southern District Engineer, who was travelling in the Edinburgh train, affords perhaps the best, and certainly an impartial, opinion as to the range of visibility at the time, namely, about a quarter of a mile.

Under such conditions, and in the absence of a repeater to the distant signal, it is very doubtful whether Signalman Sneddon was justified, in the first place, in not accepting the Dundee train in accordance with Rule 81 (*h*), without having previously ascertained why he had not received the *Out-Of-Section* signal for the goods train, which had then been standing at Dullatur East for seven or eight minutes.

Contrary to the Superintendent's interpretation of the intention of this Rule, Signalman Sneddon's practice had been to rely on obtaining *Line-Clear* ahead, to meet the contingency of inability to view his distant signal. There is no proof that such practice had a specific bearing on this case; but had he applied the Rule and arranged for Driver Macaulay to be warned at Greenhill Junction *"of the temporary absence of"* the distant signal at Castlecary, it is unlikely that the accident would have happened. Driver Macaulay would presumably have been travelling at lower speed, and would have brought the Dundee train to a stand at the home signal, or at any rate near the box, when the question of it running away, or of the acceptance of the following Edinburgh train, would not have arisen.

As it transpired, however, Driver Macaulay's failure to whistle may have confirmed Signalman Sneddon's erroneous assumption that the Dundee train had entered the section; but in spite of the exceptional circumstances in which Sneddon had endeavoured to stop the train, he did not even take the trouble to look out of the window to see whether it had come to a stand. Nor did he try to ascertain what had happened to the train, although he said he anticipated that collision with the goods train ahead was about to take place. Thus, he committed his principal mistake in accepting the Edinburgh train.

This was the chief feature of the case, and the question of the track circuit was really subsidiary; had the Dundee train come to a stand clear of it, and only 174 yards ahead of the position in which it did, the collision would nevertheless have occurred, though presumably at lower speed. Had that happened, however, Signalman Sneddon's allegations against the track circuit could not have arisen, and he would have been relieved from the specific responsibility of having infringed Block Telegraph Regulations; but his more serious responsibility for having failed to operate traffic safely would still have remained. In order to show the nature of his evidence, it has been quoted extensively; though his account of looking at the indicator while speaking to Signalman Beattie, before his acceptance at 4.32 p.m., appeared to show how carefully he was performing his duty, his explanations in various respects were so unsatisfactory that I have little hesitation in concluding that neither the track circuit, nor the indicator, failed as he alleged.

I think the fairest conclusion is that Signalman Sneddon, being considerably perturbed at the idea that the Dundee train was not going to stop, misled himself, and in consequence Signalman Beattie, into believing what he imagined to be the case *at the time*, viz., that because he assumed the train had passed into the section, the track circuit indicator must have been *clear*. It seems, however, that he was *afterwards* prepared to go to any length in stressing the care with which he viewed the indicator, in order to relieve himself of the serious criticism of having failed to perform his primary duty as a practical signalman, viz., the safe operation of traffic in whatever circumstances may arise. In brief, Signalman Sneddon was gravely to blame:—

(*a*) For accepting the Edinburgh express, without clear knowledge of the position of the Dundee train, and while actually expecting an accident to the latter.

(*b*) For accepting the Edinburgh express without warning, even if he had known what had happened to the Dundee train, when he had cause to suspect the reliability of the distant signal, owing to the Dundee train having just run away.

Although Driver Anderson was thus permitted improperly to approach Castlecary under full *Line-Clear*, this in no way relieved him of the responsibility for controlling his train in accordance with the prevailing conditions of visibility. Under these conditions, however, it is unlikely that Signalman Sneddon's evidence relating to the *Caution* aspect of the distant signal was more reliable

than that relating to the track circuit indicator. Moreover, there is the very significant coincidence that Anderson accepted the signal in good faith as *clear*, as did Macaulay before him. In his straightforward account, the former made no endeavour to exaggerate his range of view, and in the absence of proof to the contrary, I conclude that it would be unfair to criticise him, except for driving at a speed possibly in excess of that which was justified in the adverse weather conditions prevailing at the time. Driver Macaulay may also have infringed the spirit of Rule 127 (iv).

XII.—Remarks and Recommendations.

1. *Rolling Stock.*—This accident (like that at Oakley Junction on the 21st January) has given rise again to the criticism that main line rolling stock in this country is not being constructed entirely of steel; so far as safety is concerned, the ground for the criticism is that such construction lessens the risk of fire and telescoping. Progress, however, in the substitution of electric lighting for gas is materially reducing the former risk, and fire did not result from either collision.

Telescoping is the principal risk, and a great deal of consideration has been given to it. Illustrated examples of accident wreckage are frequently put forward to show how much more resisting one form of construction is than another, notwithstanding the fortuitous and widely differing effects of collision and derailment, following the results of the overriding of carriage underframes. For instance, in the event of collision, coaches of old type, as compared with those of modern and stronger construction, will, generally speaking, afford less resistance in absorbing the energy of impact; the damage to the second and fifth vehicles of the Dundee train illustrate this truism, which may also be applied to any form of construction, be it timber, composite, or all-steel.

At the same time, it must be borne in mind that there are financial limits to obsolescence, that resistance to collision or derailment is not the primary consideration in the design of passenger-carrying rolling stock, and that whatever material is utilised the energy of impact has to be dissipated in some manner. It follows that construction, from the safety aspect, should have regard to two principles, namely, (*a*) the prevention, so far as possible, of one underframe overriding the other, and (*b*) the provision, if other considerations permit, of the strongest possible body to withstand the shearing forces when telescoping unfortunately does take place.

It is, of course, possible to build coaches, as has been customary abroad in the past, with very heavy steel bodies and reinforced collision end compartments, which would be much stronger than even the latest construction in this country. But apart from prohibitive cost, such design would have a paralysing effect upon operation, owing to excessive increase in weight for the same carrying capacity. Further, as was emphasised by the Company's Chief Mechanical Engineer in his evidence, it is very doubtful whether collision between two trains composed of such unyielding carriages would have materially greater preventive effect in respect of casualties; but, naturally, such construction shows to advantage when, for instance, it is intermingled (as it certainly should not be), or collides, with carriages of lighter and older material, so that a high proportion of casualty results therein, compared with relative immunity in the heavier vehicles.

On the other hand, it is quite clear that the construction of main line rolling stock in this country could be considerably lightened, if economy were the only consideration, and if it were not for the safety requirement of making provision for a reasonable measure of strength to meet the effect of telescoping should it occur. Indeed, British practice, as now developed, provides for the shock of collision being primarily taken by a massive steel underframe, equipped with various anti-telescoping types of buffing and drawgear, and carrying a wood, or wood and steel, body structure.

(a) *Telescoping-preventive equipment.*—The Buckeye coupler and Pullman vestibule, to which the Company has wisely and persistently adhered, again proved their worth in the exceptional circumstances of this collision. The additional strength required in the frame to carry this heavy coupler, and the powerful springs at the top and bottom of the vestibule, undoubtedly make for a great measure of security against frames overriding or being thrown into

star formation. The retention of alignment of the Edinburgh express, in rear of the third coach, was remarkable, and was solely attributable to this coupler.

Although two other Companies use screw couplings instead, with special shock-absorbing buffers having large faces, such equipment cannot be so efficient from the purely telescoping-preventive aspect when speed is high. I think there is little doubt that if the tender had been fitted with a Buckeye coupler, as many of this Company's tenders are to-day, the extraordinary overriding of the first three coaches might have been prevented; but in this case the momentum which was absorbed in throwing these coaches over the engine would have had to be dissipated in greater damage in the rear of the Dundee train, and it would not be safe to assume that 13 lives would have been saved (equivalent to the number of passengers killed in the Edinburgh train).

On the other hand, the presence of the tender screw coupling clearly had no telescoping-preventive effect when the tender went down on leaving the track, though the coupling held until the leading end of the underframe of the first coach became completely buckled back, as the result of which 5 passengers were apparently killed instantly by being dropped out through the floor as the coach passed over the engine. Alternatively, the existence of a brake compartment at the leading end of this coach would presumably have saved these lives and is referred to below; but, as an illustration of the danger of assumptions of this kind, a lady who was travelling in this coach escaped with merely a bruised eye and very slight shock.

(b) *Body Construction* (*Main Line Rolling Stock*).—While, therefore, this Company mainly relies on the above-mentioned drawgear to safeguard telescoping—which did not take place in the accepted sense of the word, even between the sixth and seventh coaches of the Dundee train—the body of the carriage itself has for many years been constructed mainly of wood. Into longitudinal main timbers (the bottom sides which are bolted to the solebars, and the cant rails which carry the roof) the teak pillars of the framing are secured by mortice and tenon, supported by pressed steel knees; the panelling consists of $\frac{3}{8}$ in. teak, and the roof boards are of $\frac{7}{8}$ in. tongued and grooved deal, screwed on to steel roof channels. The ends of the coach are curved and reinforced by heavy teak timbers, which form and support the vestibule and its spring gear at top and bottom.

A coach of the Company's typical construction, such as those on the train in question, weighs about 32 tons; of this, steel and iron in the underframe, bogies, and body weigh 21 tons, or 66 per cent.; the timber in the body weighs 7 tons or 22 per cent.; and batteries, dynamo, steam heating and brake equipment, glass, lavatories, internal fittings, paint, etc., account for the remaining 4 tons, or 12 per cent. Generally, the corresponding construction of the other Companies comprises steel panelling on hardwood timber framing with steel roofing, and includes British Standard vestibules with flat ends to the body, instead of the heavy timber body and framing which is used on L.N.E.R. coaches in combination with Pullman vestibules; the proportion of steel is thus raised to about 80 per cent. of the total weight.

The criticism referred to above, that steel should be substituted for wood, does not therefore relate to more than about seven tons of wood, as a maximum for this Company's stock, in a total weight of some 32 tons. On the other hand, considerable experience has already been gained in this respect; as long ago as 1922, the Company built a few all-steel dining cars, which are now being scrapped, due to deterioration of the steel panelling and to the excessive cost of maintenance. Further, in 1927 a number of all-steel thirds and brake vans were provided, but they proved to be two or three tons heavier, were more expensive, and involved higher maintenance. Since then the all-steel Pullman cars on the "Queen of Scots" were brought into service in 1928, and the most recent all-steel carriages are those which have been built for the Tyneside electrification.

I have fully discussed the matter again with the Company's Chief Mechanical Engineer, whose latest construction in the "Jubilee," "Coronation," "West Riding," and outer suburban services—besides including articulation which has material anti-telescoping advantages—embodies steel panelling on a teak framing, in order to present a flush exterior and to facilitate cleaning. His opinion, as

the result of long experience, is that *for equal weight* a body framing of steel is not likely to be so strong, or so reliable in maintenance, as a massive teak structure.

But, having regard to the recent developments mentioned above, I feel that such rapid progress is now being made in the use of high tensile steels, alloys, and welding, that the time should not be far distant when the factors of insufficiency of strength, and unreasonably increased weight, cost, and maintenance, will no longer render impracticable the more general use of what may be termed light-weight all-metal construction.

It is misleading, however, to suggest that such construction would have withstood the terrific shock of this collision any better than the heavy steel underframes and timber bodies of the coaches concerned, six of which were wrecked, four being of the latest design; the significant crumpling of the underframes themselves has already been referred to. Indeed, it might be argued that the severity of an accident may well be increased by the presence of an all-metal body, if the oxy-acetylene blowpipe had to be brought into use to liberate imprisoned and injured passengers.

On the whole, therefore, from the safety aspect, the Inspecting Officers consider that this Company's policy of adhering to articulation, the Buckeye coupler, and the Pullman vestibule has outstanding merits, and there is no justification, on either that or other grounds, for pressing Main Line Companies unduly to accelerate departure from their general practice of carriage construction, which, having regard to weight and cost, is gradually attaining the ideal of greater, but uniform, strength throughout the train. In fact, as I have said before, I have no hesitation in supporting the policy of all the Companies, which is primarily to direct available resources towards the prevention of accidents, as well as to minimise their effects when they unfortunately occur.

2. *Marshalling.*—As stated above, it seems likely that five passengers were killed in the Edinburgh train because the leading brake compartment (third coach) was not marshalled next the engine, two passenger-carrying vehicles having intervened. An Instruction on this subject was issued in the Southern Scottish Area on 28th May, 1923, which read as follows:—

> (*d*) *Brake Compartments next Engines.*—All Passenger Trains which are provided with two Brake Vans or Brake Third Class Coaches should, when practicable, have one of these vehicles marshalled next the Engine. When, however, passenger carrying coaches are placed next the Engine, it will not be necessary to lock up two empty compartments of the leading vehicle.

The previous practice of locking up compartments next the engine was discontinued by the Companies, owing to the inconvenience in working and to the impracticability of carrying out the Instruction in the case of corridor stock. The present Instruction, which appears to be generally applicable, is contained on page 66 of the Southern Scottish Area Appendix dated 1st March, 1937, and reads as follows:—

> (*g*1) *Brake Compartments next Engines.*—All passenger trains should, when practicable, have a brake compartment next the engine.

I was informed by the Company's Superintendent that this Instruction has been regarded as only imposing an obligation to marshal passenger-carrying vehicles inside the brake van when this could be done without inconvenience to the working or without causing delays, and the matter was referred to in my Report upon the accident at Shrivenham in 1936.

With regard, however, to the marshalling of the Edinburgh express in future, the Superintendent has now arranged to roster one of the vehicles in question as part of the train set, thus allocating it permanently within the front brake van. He has also undertaken to marshal the second vehicle within the brake van under normal conditions; I understand that this arrangement will be prevented only when traffic conditions are exceptional. The attachment of the latter vehicle has to be effected at Edinburgh before the train departs, as it is only required for service between Edinburgh and Glasgow.

I recommend that further consideration be given to this matter by the Companies generally, with a view, where necessary, to influencing the Traffic Staff towards the attachment of all additional vehicles within a brake van, rather than to permit inconvenience to be urged as a reason for not applying this precaution in the marshalling of passenger trains.

3. *Rules and Regulations.*—(a) As part of the argument in extenuation of his failure on this occasion, Signalman Sneddon actually suggested that the acceptance of a following train should be specifically prohibited in circumstances such as he alleged existed when he transmitted the *Vehicles-Running-Away* signal for the Dundee train. Apart from the undesirability of adding to an already overburdened code of Rules and Regulations, I think the suggestion is entirely unnecessary as a guide to practical signalmen; as is confirmed by the care with which traffic is generally operated, particularly in bad weather conditions, it is certainly better to leave a matter of this kind to their initiative and commonsense.

(b) *Rule* 55. The driver of the Dundee train could not have been expected to whistle when he observed the emergency red light displayed from the box; but, in accordance with this Rule, he should have done so when he stopped at the starting signal, although he came to a stand on a track circuit. I recommend that consideration be given to including a specific reminder in this respect, similar to the procedure adopted by the Great Western and Southern Railways.

(c) *Rule* 81(*h*). I understand that this originated in 1897, and it appeared in the North British Railway Rule Book in the following wording:—

> 73 (1) The Signalman at the Box in the rear must, when practicable, be advised if the Distant or Home Signal cannot be placed at Danger, and he must stop all trains proceeding in the direction of the defective Signal and advise the Engine-drivers of the circumstance.

The rule remained unaltered until 1922, when questions were raised with regard to making it cover, for instance, the contingencies of a signal being blown down and taking some days to replace, and lights being blown out or failing. It was, therefore, amplified in 1923 to the general form in which it stands to-day, as already stated. There was again some amendment in 1930, but the Rule, then 81(*h*), practically remained unchanged. It has clearly been based on the assumption that the signalman is aware when his signals become defective, and for this reason the provision of repeaters is necessary. In the absence, however, of a repeater, it seems that the words "*the temporary absence of such a signal*" may not be sufficiently explicit to cover what the Company's Superintendent stated was the intention of the Rule, namely, that it should be applied, in such circumstances, when the signalman cannot see the signal.

For this reason, apparently, the North British Railway Company's Appendix of October, 1922, contained the following Instruction, which has been recently cancelled:—

> 4. *Foggy Weather or Falling Snow—Rules* 58 *and* 78 *to* 86 *inclusive.*
> (*b*3) In all cases where the Signalmen are not perfectly satisfied that their Distant Signal Arms are going properly to danger no train must be accepted from the Box in the rear until it has been offered to and accepted by the Box in advance.

As already mentioned, however, Signalman Sneddon said he was continuing to pursue this practice, in the event of his not being able to see the distant signal; having regard, therefore, to the likelihood that the signal was not, in fact, within his view during this snowstorm, and that he could not be depended upon to judge whether the signal was working properly or not, it would appear desirable that any doubt should be removed as to the intention and application of this Rule in future, viz. by suitable definition of the words referred to above, in order to ensure that operation of traffic will be brought under the Rule, in the absence of a repeater, when the signalman cannot view the signal arm or backlight concerned.

4. *Signalling.*—This accident illustrates the importance of the distant signal to the driver, having regard to his faith in the integrity of the signalman's operation. In this case, as stated above, the signalman had no repeater of the position of the signal, nor can it be reliably said that he could assure himself as to its aspect by direct vision, in view of the weather conditions which obtained. In the circumstances, therefore, as the accident has proved, neither of the drivers concerned should have been allowed to approach Castlecary unwarned.

Such operation, however, would have involved delay, which Signalman Sneddon was apparently accustomed to avoid by his readiness to take the risk that the distant signal was working properly, though he may not have been able to see it. It has been the practice of all Companies for many years to assist signalmen in this respect by providing repeaters; these instruments, however, are not positive safeguards as their indication may be overlooked or ignored.

The only way, therefore, to ensure that a train is not permitted to approach (unwarned) unless the signal is working properly is to prove it in its *Caution* position by means of a positive control on the block instrument. This *interlinking* between the signal and the block instrument also has the advantage of ensuring that the signalman correctly adjusts the signal wire under adverse weather conditions, and if the down distant signal was *drooping* or *falsely-clear* on the occasion in question, such a comparatively inexpensive safeguard should have averted this accident (*vide* last paragraph of my Report on the collision at Ashchurch, 8.1.29.).

The above-mentioned equipment (i.e. signal repeaters and proving apparatus) has already been installed on the Edinburgh-Glasgow main line to the extent of 81 per cent. and 31 per cent. respectively of the distant signals, and I strongly recommend the early completion of such work on all main lines subject to high speed. The corresponding figures, for instance, for the Edinburgh-Berwick main line are 84 per cent. and 67 per cent. respectively. It is also of the greatest importance that the view of the distant signal, and the interval between it and the home signal, should be adequate for all classes and speeds of traffic using the line.

Though there was no proof that it had any bearing on the circumstances, it would also be well to consider providing the controls referred to in my Report on the accident at Welwyn Garden City in 1935, on, for instance, the track circuit in rear of the down home signal at Dullatur East, if this is not already contemplated in connection with the re-modelling of the signalling at Castlecary; this work was to be carried out in any case as part of the programme for this year, and will, in accordance with the Company's practice, include locking to secure the sequential return of signals to danger.

On the other hand, there is the possibility, as I have stated, that the distant signal in question was at *Caution* when both expresses approached the station. In this alternative, the accident could have been prevented by a system of Automatic Train Control; by this means Driver Macaulay, and, if it had been subsequently necessary, Driver Anderson, would have received a positive indication of the position of this signal, and an automatic application of the brake. Such equipment would also, of course, have safeguarded the position had the signal been *drooping* or *falsely-clear*.

5. *Automatic Train Control.*—This came into prominence in 1900, following the accident at Slough, where a driver ran past a number of signals at danger (in clear weather); Departmental Committees reported on the subject in 1922 and 1930. The term covers a wide field of appliances primarily intended to prevent collisions and designed to assist drivers to observe and obey outdoor signals, the indications of which are thereby communicated in the cab by means of a device carried on the engine and actuated by apparatus on the track. The four types are as follows:—

(*a*) The *Train-Stop* is the simplest, and in many respects the most efficient form of intermittent equipment, whereby the brake is automatically and irrevocably applied at a stop signal if passed at danger. The installation throughout the railways on which the trains of the L.P.T.B. operate is of contact type; the cost of the actual equipment for each motor car and signal location is roughly £20 and £200 respectively, and the exceptional security of this very dense traffic is mainly ensured thereby. Where train speeds, however, are high, as on main lines, the Control appliance should come into action before the stop signal is reached, and the *Train-Stop* of contact type is not suited to such operation.

(*b*) The *Warning Control* is, therefore, designed not to compel an irrevocable stop, but to convey a warning to the driver of the presence of a stop signal ahead. It is usually associated with the distant signal, in conjunction with which it is controlled, and it can be of contact or non-contact type. The warning is usually given by audible indication, combined with a brake application which can be cancelled by the driver's acknowledgment; when the signal is clear, a distinctive audible indication is also given. The device in its simplest form may provide merely a *Location Control*, giving at all times the warning indication whether the signal is at caution or clear.

The G.W.R. has had contact apparatus of this intermittent type in successful use for over 25 years, and, during the whole of this period, only three danger-side failures have occurred; the equipment is now installed over the greater part of the system, viz. all the main, and important cross-country, lines. Including recent additions under the Guaranteed Loan Scheme, 1935, some 3,250 engines have now been equipped and 2,110 signal locations, covering 2,850 track miles. First cost of engine and track equipment (including dual warning and clear effect, and proving the arm and lever) appears to be about £50 each (*vide* Appendix V of the later Departmental Committee's Report); total cost, therefore, including engine equipment, has amounted to about £100 per track mile, averaged over the whole system.

The L.M.S.R. has also been experimenting for some years on the Southend line with Hudd non-contact inductive apparatus, in accordance with the recommendation of the later Committee; it appears that satisfactory progress has been made, and the Company's Report is awaited. The equipment is similar in scope and function to the G.W.R. apparatus, though quite different in its method of working, and its cost appears to be comparable; from the traffic and control aspects also, the two devices are, or can be made, so similar in effect that they may be regarded as equivalent.

(*c*) The *Cab Signal* is a means by which signal indications ahead are repeated, visually or audibly, in the cab, without necessarily including any apparatus to control the speed of the train or to cause a brake application. The equipment may be of the intermittent (contact or non-contact) or continuous type.

(*d*) *Continuous Control* is only possible with continuous track circuiting, and there are many different systems; they may combine not only the Train-Stop and Warning Control, but Speed Control, and frequently, also, Cab Signals. It was pointed out, however, in the later Committee's Report, that although such systems can "*undoubtedly provide the most complete direct protection against accident*", the very heavy expenditure involved would not be justified, "*having regard to the high degree of security now maintained on British Railways*".

In the United States, there now seems to be some tendency to utilise the Cab Signal alone, and to revert from systems embodying the brake control feature. At the present time, there are nearly 15,000 track miles and 5,500 engines equipped with Train-Stop and other Control devices, including some 2,700 track miles and 1,000 engines with Cab Signals; in addition, the Cab Signal appears to be provided alone over nearly 5,000 track miles and on some 3,000 engines.

In France, the Cab Signal of intermittent contact type has been in operation for many years, and has now been extended in improved form to all important main lines, indications being given, in principle, only at the distant signal, with no brake control. In Belgium, the same type of equipment has been installed on certain main lines to meet the requirements of inter-running with the French system. In Italy, as the result of recent trials, it has also been decided to equip certain high speed lines with intermittent Cab Signal apparatus of electro-magnetic type in connection with the distant signal.

In Germany, on the other hand, the equipment provides for Speed Control and automatic braking, but there is no Cab Signal; it is installed on virtually all main lines carrying high speed traffic (4,000 route miles being in course of completion). It is applied in connection with distant and stop signals, and is non-contact, of the electro-magnetic inductive type. In Switzerland, somewhat similar, but simpler equipment, functioning in conjunction with the distant signal, is in use on the electrified lines.

The advantages of Control appliances are, therefore, generally recognised, and the fact that safety is thereby improved admits of no dispute. After an accident, however, of the nature of Castlecary, it is important neither to exaggerate the extent to which casualty would be prevented by such equipment, nor to ignore other methods for attaining increased security. The later Committee referred in 1930 to various "*indirect*" means, in addition to such "*direct*" means, by which enginemen can be assisted; though the Committee said that the latter was "*generally to be preferred*", and recommended the adoption of a

simple system of *Warning Control,* they expressed the opinion, for various reasons, that each Company should determine on what sections of line either or both means should be adopted.

They also remarked with regard to multiple-aspect signalling that the necessity for *"further protection or Control where this method of signal lighting is installed appears to be less urgent than in the case of similar signals with ordinary lighting. But cases of accident . . . demonstrate the fact that even with this type of powerfully lighted signal, misreading or mistaking of signals sometimes occurs, and the safeguard afforded by better lighting is not therefore complete".*

Since then much progress has been made in improving lighting, and in providing colour-light equipment; it is possible that such a signal at the location in question would in itself have prevented this accident, and distant signals of this type are being introduced on main lines. The advantages of safeguards of this *"indirect"* kind—including the interlocking of signals with block instruments, and the proving of one signal at danger before the other in rear will clear—are that they are effective for every movement, without the necessity for appliances on any of the trains concerned; thus more can perhaps be done for a given expenditure towards improving safety conditions and making easier the task of the careful driver, particularly in bad weather. It can also be said that it is better to improve the display, location, etc., of signals before supplementing them by Control devices.

On the other hand, it may fairly be said that the only *positive* safeguard against certain classes of accident at high speed, such as that which occured at Castlecary, is some form of Automatic Train Control. If it were to provide for all the contingencies involved, it would have to be complete: but, as stated above, the cost would not be justified, and *Warning Control,* which includes the automatic brake application, goes some way to meet requirements (*vide* the statistics given below).

Admittedly there are difficulties in combining two-indication *Warning Control* equipment with a multiple-aspect colour-light signalling system, and, where the latter is being extended on, for instance, the heavily trafficked medium speed suburban and urban lines of the Southern Railway, it should take preference, together with such other *"indirect"* measures as modernisation of block apparatus, by which security of train movement will be enhanced. But the majority of the track mileage of the heavy main lines of the country will remain for many years signalled under the two-aspect (mainly semaphore) system, on which is now being imposed the control of services operating at ultra-high speeds.

Considering, therefore, both types of equipment as additional aids to the driver, a not unsatisfactory compromise would apparently result by omitting Control for the present under multiple-aspect signalling while applying it under the two-aspect system. Similarly, its installation may be logically restricted to certain routes and certain trains under high speed operation, the track apparatus being located at suitably varying distances in rear of distant signals, to give adequate warning dependent upon maximum speed at each place, and possibly rendering it practicable to dispense with special block working instructions which are now applicable to these trains only.

The effect of the application of a simple *Warning Control* system is shown by the researches of both Committees in connection with all the cases of accident into which Ministry Inquiries were held. During the ten years ended 30.9.21, it would have provided an effective remedy in 25, or 13 per cent., of the 193 accidents, although 71, or 37 per cent., and perhaps more in all, might have been beneficially affected by Control in one form or another, viz: Speed, Continuous, intermittent Warning and Train-Stop. In the eight years ended 30.9.29 during which 172 Inquiries were held, the figure of 37 per cent. diminished to 29 per cent. (50 cases), although the average for train-mileage increased meantime from 372 millions to 392 millions.

In the eight years ended 31.12.37, during which 112 Inquiries were held, this figure is again lower at 28 per cent. (31 cases), while 13 accidents, 12 per cent., incuding Castlecary, might have been prevented by *Warning Control,* train-mileage having increased still further to an average of 427 millions, the figure for 1937 being 456 millions (including the L.P.T.B.).

The element of chance in the incidence of casualty is also illustrated by the fact that the fatalities in this accident represent 46 per cent. of the total of 76 which resulted from the 31 accidents during the 8-year period 1930-37. In addition, however, to the cases of actual train accident which might have been prevented by some Control device, the number of potential collisions, due to disregard of signals, should not be overlooked.

While I recognise that this is a contentious and difficult subject, the foregoing is an attempt briefly to indicate the progress which has been made up to date with regard to the provision of Control appliances, and the extent to which such equipment would have been effective in this country; also the considerations bearing upon the provision of "*indirect*" means for attaining additional security in train movement.

The constituent companies of the L. & N.E.R. have experimented in the past with a number of devices and these are referred to in the Reports of the two Committees. The Company's problem appears to be similar to that of the L.M.S.R., and both should adopt the same equipment; in the main, the problem is the adaptation of the two-aspect semaphore system to meet the demands of increasing speed, and the necessity for doing everything possible to assist drivers, particularly in adverse weather conditions, reliably to observe and obey signals while still maintaining schedule. I feel that preference in consideration and expenditure should be given to perfecting the existing system of signalling, and its corresponding safeguards; also to the application of a system of *Warning Control,* as has now been widely accomplished on the G.W.R., to the admitted satisfaction of officers and men and to the benefit of time-keeping in bad weather.

Having regard, therefore, to all the circumstances of this serious accident and to the criticism, to which my attention was particularly drawn, that both drivers concerned, though running approximately on time, may have been exceeding a speed reasonably justified by visibility conditions, I recommend that the Company should take early steps to reach decisions, with a view to applying *Warning Control* to high speed services on their Trunk Routes. I understand that the Company are in active collaboration with the L.M.S.R. on this subject, and I hope that such equipment will prove successful in maintaining the existing high standard of safety.

6. A number of suggestions have been received from the public in connection with this accident, and all have been carefully considered; none of them, however, seemed to be of sufficient importance to warrant specific reference.

In conclusion, I have to acknowledge the unfailing assistance of all the Company's officers, particularly in connection with the preparation of the evidence, the plans, and other technical information; also the help of the representatives of the three Unions concerned.

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

A. H. L. MOUNT,
Lieut.-Colonel.

The Secretary,
Ministry of Transport.

Note.—Before the Lord Justice-Clerk, in the High Court of Justiciary at Edinburgh, and a jury of nine women and six men, Driver D. J. Anderson was tried on a charge of culpable homicide on the 30th March. The Lord Advocate withdrew the charge on the 31st March, the jury was directed to return a verdict of "Not Guilty", and Driver Anderson was discharged.

APPENDIX I.

CASTLECARY ACCIDENT—10TH DECEMBER, 1937.

Report on Meteorological Conditions.

In the period 6th to 10th December temperatures were generally low. The maximum and minimum values recorded by thermometers exposed under standard conditions at Abbotsinch (near Renfrew) and at Stirling were as follows :—

Date.	Abbotsinch.		Stirling.	
	Maximum.	Minimum.	Maximum.	Minimum.
	°F.	°F.	°F.	°F.
December 6th	38	33	37	31
,, 7th	39	24	37	32
,, 8th	37	30	37	31
,, 9th	36	27	35	33
,, 10th	34	20	36	26

It will be observed that the range of temperature during the period was 19 degrees Fahr. at Abbotsinch and 11 degrees at Stirling.

Detailed observations made at Abbotsinch indicate that, apart from some sleet showers in the early hours of the 6th, there was no measurable precipitation until 9.20 a.m. on the 10th when intermittent slight snow occurred. The snowfall became more intense at 11.40 a.m. and thereafter fell continuously until 5.0 p.m., when it changed to sleet. Within an hour it had changed to very light rain and had practically stopped at 6.0 p.m. The depth of undrifted snow was 3 inches. The fall may have continued rather later at Castlecary.

A moderate south-easterly wind prevailed during the 10th until evening, when it backed slowly to north-east and precipitation ceased.

The following table sets out the meteorological observations at Abbotsinch during each hour from 9.0 a.m. to 6.0 p.m. on December 10th :—

Hour.	Present Weather.	Weather since last Observation.	Visibility.	Temperature.		State of Ground.
				Dry.	Wet.	
9 a.m. ...	Slight mist ...	Moderate fog and frost.	2,000 yards			Partly covered with snow.
10 a.m. ...	Intermittent slight snow.	Slight snow commenced at 9.20 a.m.	2,000 ,, ...	32·0	30·8	Partly covered with snow.
11 a.m. ...	Continuous slight snow.	Intermittent slight snow.	2,000 ,, ...			
12 noon ...	Continuous moderate snow, moderate fog.	Slight snow becoming moderate at 11.40 a.m.	700 ,, ...			
1 p.m. ...	Continuous moderate snow and fog.	Continuous moderate snow with fog.	500 ,, ...	32·5	32·2	Covered with snow (about 1 in.).
2 p.m. ...	Continuous moderate snow and moderate fog.	Continuous moderate snow with fog.	600 ,, ...			
3 p.m. ...	Continuous moderate snow with fog.	Continuous moderate snow. Moderate fog.	500 ,, ...			
4 p.m. ...	Continuous moderate snow with fog.	Continuous moderate snow with fog.	500 ,, ...	32·8	32·5	Covered with snow less than 3 in. deep.
5 p.m. ...	Slight sleet and moderate fog.	Continuous moderate snow with fog. Snow changed to sleet at 4.55 p.m.	600 ,, ...			
6 p.m. ...	Very slight rain and moderate fog. (Precipitation had practically stopped.)	Slight sleet turning to very slight rain at 5.50 p.m. with moderate fog.	900 ,, ...	33·1	32·8	Covered with snow 3 in. deep.

The observations show that during the afternoon visibility was frequently reduced to 500 yards.

At Stirling regular observations are made only at 9.0 a.m.; there is, however, a note that at 4.30 p.m. on the 10th there was 4½ inches of snow outside the municipal buildings.

Observations made further east—at Leuchars Aerodrome (Fife)—show that visibility on the afternoon of the 10th was generally about 1,000 yards, but fell to 500 yards around 3.0 p.m. Slight snow fell there from 12.30 p.m.; it became heavy between 2.0 p.m. and 3.0 p.m., moderate from 3.0 p.m. to 4.45 p.m., and then changed to heavy sleet which continued until midnight.

(Sgd.) A. H. R. GOLDIE,

Superintendent.

Meteorological Office,
Edinburgh.
22nd December, 1937.

APPENDIX II.

WEATHER CONDITIONS AT SPRINGBURN PUBLIC PARK, GLASGOW, FOR THE PERIOD 6TH TO 13TH DECEMBER, 1937—READINGS TAKEN AT 9.0 A.M. DAILY.

	Temperature.			Visibility	General Remarks.
	Grass.	Max.	Min.		
6th	29	36	30	Good	Bright periods—snow lying—frost night—2·1 hrs. sun.
7th	23	37	29	Good	Fine, bright, cold—snow lying—4·2 hrs. sun.
8th	25	35	29	Fair	Dull cold day with frost night—nil sun.
9th	26	34	31	Good	Dull cold frosty day—nil sun.
10th	20	34	24	Fair	Stormy day—snow falling—nil sun.
11th	27	35	28	Good	Dull or cloudy cold day—nil sun.
12th	15	33	23	Good	Bright cold—snow at night— 5 hrs. sun.
13th	14	38	17	Dull	Stormy, cold—snow falling—nil sun.

Range of visibility—Good—2,500 yards.
Fair—1,500 yards.
Dull—250 yards.

APPENDIIX III.

ACCIDENT AT CASTLECARY, 10/12/37.

MARSHALLING AND DESCRIPTION OF CARRIAGES.

2.0 p.m. Express Passenger Train, Dundee to Glasgow.

No.	Type of Vehicle.	Where Built and Date.	Material of Underframe.	No. of Compts.		No. of Seats.		Weight.		Bogie Centres.		Overall Height.		Overall Width.		Length Over Body.		Length Over Vestibule.	Length Over Buffers.
				F.	T.	F.	T.	T.	C.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	Ft. In.	Ft. In.
*3435	Brake Third	N.E. York 1931	All Steel		4		32	31	15	43	0	12	10	9	3	61	6	Total Length over Vestibules 433' 6".	Total Length over Buffers Coaching Stock, 467' 5".
31061	Third ...	N.E. York 1906	Steel with Wood Headstocks, End Longitudinals and Diagonals.		8		64	32	10	41	6	12	11⅛	8	10½	58	6		
32286	Composite ...	N.E. York 1935	All Steel	3½	4	21	24	33	0	43	0	12	10	9	3	61	6		
*3372	Brake Third	N.E. York 1930	All Steel		4		32	31	15	43	0	12	10	9	3	61	6		
31083	Third ...	N.E. York 1906	Steel with Wood Headstocks, End Longitudinals and Diagonals.		8		64	32	10	41	6	12	11⅛	8	10½	58	6		
*31044	Brake Third	Metro-Cammell Co. 1936	All Steel		4		24	31	5	43	0	12	10	9	3	61	6		
32306	Composite ...	N.E. York 1935	All Steel	3½	4	21	24	33	0	43	0	12	10	9	3	61	6		
749124	Fish Van ...	Hurst Nelson 1920	Wood	—	—	—	—	13	1	Wheelbase 20	0	12	3⅜	8	5½	30	0		
Total 8 Vehicles ...				7	36	42	264	225	15										

● Emergency Equipment fitted in Brake Compartment.

APPENDIX IV.

ACCIDENT AT CASTLECARY, 10/12/37.

MARSHALLING AND DESCRIPTION OF CARRIAGES.

4.3 p.m. Express Passenger Train, Edinburgh to Glasgow.

No.	Type of Vehicle.	Where Built and Date.	Material of Underframe.	No. of Compts. F.	No. of Compts. T.	No. of Seats. F.	No. of Seats. T.	Weight. T.	Weight. C.	Bogie Centres. Ft.	Bogie Centres. In.	Overall. Height. Ft.	Overall. Height. In.	Overall. Width. Ft.	Overall. Width. In.	Length. Over Body. Ft.	Length. Over Body. In.	Length. Over Vestibule. Ft. In.	Length. Over Buffers. Ft. In.
3674	Third	N.E. York 1936	All Steel	—	7	—	42	32	15	43	0	12	10	9	3	61	6	Total Length over Vestibules 562′ 0″	Total Length over Buffers Coaching Stock. 562′ 6″.
31090	Third	G.N. Doncaster 1907	,, ,, ...	—	8	—	64	29	17	41	0	12	11¾	8	10½	58	6		
*3296	Brake Third ...	N.E. York 1936	,, ,, ...	—	4	—	24	31	5	43	0	12	10	9	3	61	6		
3943	Third	Metro-Cammell 1935	,, ,, ...	—	7	—	42	32	15	43	0	12	10	9	3	61	6		
327	Open Third ...	N.E. York 1934	,, ,, ...	Saloon 2	—	—	48	32	0	43	0	12	10	9	3	61	6		
†31868	Rest. Car ...	G.N. Doncaster 1934	,, ,, ...	2 Saloon		30	—	44	8	43	0	12	10½	9	3	61	6		
31885	First ...	Cravens Rly. 1930 / C. & W. Co.	,, ,, ...	7	—	42	—	34	10	43	0	12	10	9	3	61	6		
3939	Third	Metro-Cammell. 1935	,, ,, ...	—	7	—	42	32	15	43	0	12	10	9	3	61	6		
*31060	Brake Third ...	Metro-Cammell. 1936	,, ,, ...	—	4	—	24	31	5	43	0	12	10	9	3	61	6		
Total 9 Vehicles ...				7 2 Saloon Saloon 2	37	72	286	301	10										

* Emergency Equipment fitted in Brake Compartment.

† 2 "Simplex" Fire Extinguishers and 1 "Pyrene" Fire Extinguisher, in the Kitchen.

APPENDIX V.

LONDON AND NORTH EASTERN RAILWAY.

ACCIDENT AT CASTLECARY—10/12/37.

Statement of Condition of Buckeye Couplers and Pullman Vestibules, 2.0 p.m. Passenger Train Dundee to Glasgow.

Formation.	Particulars taken from Debris at Cowlairs Works. Couplers.	Position Immediately After Accident.	Particulars taken from Debris at Cowlairs Works. Vestibules.
ENGINE No. 9896	Screw Coupled.	Screw Coupled.	
1. THIRD BRAKE 3435.	*Leading Coupler* in Down Position closed. Coupler in good order.		Good Order.
	Trailing Coupler in Up Position closed. Coupler in good order	Coupled.	Good Order.
2. THIRD 31061.	*Leading Coupler* in Up Position closed. Coupler in good order.		Good Order but landing plate slightly bent.
	Trailing Coupler in Up Position closed. Coupler in good order.	Coupled.	Good Order but landing plate bent.
3. COMPO 32286.	*Leading Coupler* in Up Position closed. Coupler in good order.		Good Order.
	Trailing Coupler in Up Position closed. Coupler in good order.	Coupled.	Good Order.
4. THIRD BRAKE 3372.	*Leading Coupler* in Up Position closed. Coupler in good order.		Good Order.
	Trailing Coupler in Up Position closed.	Coupled.	Faceplate slightly bent.
5. THIRD 31083.	*Leading Coupler* in Up Position closed. Coupler intact but had been burnt off to separate.		Faceplate slightly bent.
	Trailing Coupler. Coupler intact but had been torn from underframe.	Torn from frame. Not coupled.	No trace.
6. THIRD BRAKE 31044.	*Leading Coupler* in Up Position closed. Coupler intact.		No trace.
	Trailing Coupler in Up Position closed. Coupler intact but lugs bent.	Not Coupled.	No trace.
7. COMPO 32306.	*Leading Coupler* in Up Position closed. Coupler in good order.		No trace.
	Trailing Coupler in Down Position closed. Coupler in good order.	Coupler had been torn from frame.	No trace.
FISH 749124.		No trace of screw coupling from Fish Van.	

Statement of Condition of Buckeye Couplers and Pullman Vestibules, 4.3 p.m. Passenger Train, Edinburgh to Glasgow.

Formation.	Particulars taken from Debris at Cowlairs Works. Couplers.	Position Immediately After Accident.	Particulars taken from Debris at Cowlairs Works. Vestibules.
ENGINE 2744.	Screw Coupling at back of tender broken at screw.	Screw Coupling of Tender broken.	
1. THIRD 3674.	*Leading Coupler* in Down Position closed. Coupler intact. Drawhook intact.	Coupler down not in use.	No trace.
	Trailing Coupler in Up Position closed. Coupler intact.	Not coupled.	Faceplate slightly bent.
2. THIRD 31090.	*Leading Coupler* Missing. Presumed broken.		No trace.
	Trailing Coupler Missing. Presumed broken.	Not coupled.	No trace.
3. BRAKE THIRD 3296.	*Leading Coupler* in Up Position closed. Coupler intact.		No trace.
	Trailing Coupler only one lug at pivot pin in position—pin bent. Remainder of coupler broken off.	Coupler broken. Coaches slightly out of line.	Faceplate bent.
4. THIRD 3943.	*Leading Coupler* in Up Position closed. Coupler in good order except both lugs bent.		Faceplate bent
	Trailing Coupler Missing. Coupler burnt off.	Coupled.	Faceplate slightly bent.
5. OPEN THIRD 327.	*Leading Coupler* Missing. Coupler burnt off.		Faceplate slightly bent.
	Trailing Coupler Missing. Coupler burnt off.	Coupled.	Faceplate slightly bent.
6. RESTAURANT CAR 31868.	*Leading Coupler* Missing. Coupler burnt off.		Faceplate slightly bent.
	Trailing Coupler in Up Position closed. Pin bent. Coupler intact.	Coupled.	Faceplate in good order.
7. FIRST 31885.	*Leading Coupler* in Up Position closed. Coupler in good order.		Faceplate in good order.
	Trailing Coupler in Up Position closed. Coupler in good order.	Coupled.	Faceplate in good order.
8. THIRD 3939.	*Leading Coupler* in Up Position closed. Coupler in good order.		Faceplate in good order.
	Trailing Coupler in Up Position closed. Coupler in good order.	Coupled.	Faceplate in good order.
9. BRAKE THIRD 31060.	*Leading Coupler* in Up Position closed. Coupler in good order.		Faceplate in good order.

APPENDIX VI.

Tests taken on No. 14 Down Distant Signal, Sunday, 16th January, 1938.

Travel of Distant Signal Wire leaving cabin = 16".
" " " " at signal = 4⅛".

Therefore Slack Wire = 11⅞".

Test (1). No. 14 Distant Lever normal and all tension taken off wire :—When lever pulled the arm came off to approximately 35° and when lever put back slowly the arm assumed the horizontal position with the lever mid-stroke.

Test (2). Distant Wire taken up 2⅛" equivalent to approximately 10° F. variation in temperature. When lever pulled the arm came well " off " and when lever restored slowly the arm returned fully to the " on " position with the lever mid-stroke.

Test (3). Distant Wire taken up 4¼" equivalent to approximately 20° F. variation in temperature. When lever pulled the arm came well " off " and when lever restored slowly the arm returned fully to the " on " position with the lever two-thirds back.

Test (4). Distant Wire taken up 6⅜" equivalent to approximately 30° F. variation in temperature. When lever pulled the arm came fully " off " and when lever restored slowly the arm returned full " on " with lever 2" off normal position.

Test (5). Distant Wire taken up 8½" equivalent to approximately 40° F. variation in temperature. When lever pulled the arm came fully " off " and when lever put back slowly the arm returned full " on " when lever 1" off normal position.

Test (6). Distant Wire taken up 10⅝" equivalent to approximately 50° F. variation in temperature. When lever pulled the arm came fully " off " with lever two-thirds over and when lever put back slowly the arm only assumed the " on " position when lever was fully back in its normal position.

Test (7). Distant Wire taken up 12¾" equivalent to approximately 60° F. variation in temperature. When lever pulled the arm came fully " off " with lever approximately mid-stroke. When lever put back slowly and was normal in frame the arm was drooping about 10° off the horizontal.

Time. Between 12.30 p.m. and 1.30 p.m.

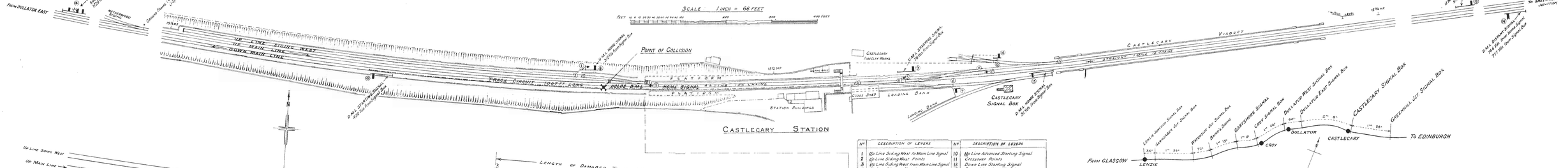
Weather. Snowing at first but turning to rain—ground barely covered with snow.

Tests taken by Mr. Moss, Signal and Telegraph Engineer, in the presence of Mr. Rattray, District Engineer.

LONDON NORTH EASTERN RAILWAY — SCOTTISH AREA

COLLISION AT CASTLECARY — 10TH DECEMBER 1937.

DRAWING 'A'



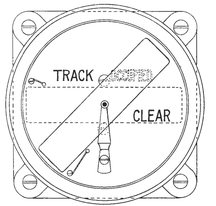
Nº	DESCRIPTION OF LEVERS	Nº	DESCRIPTION OF LEVERS
1	Up Line Siding West to Main Line Signal	10	Up Line Advanced Starting Signal
2	Up Line Siding West Points	11	Crossover Points
3	Up Line Siding West from Main Line Signal	12	Down Line Starting Signal
4	Up Line Distant Signal	13	Down Line Home Signal
5	Crossover Down to Up Line Signal	14	Down Line Outlet Signal
6	Down Line Sidings Points	15	Up Line Sidings East Points
7	Down Line Sidings Signal	16	Up Line Sidings East Signal
8	Up Line Home Signal	17	Crossover Up to Down Line Signal
9	Up Line Starting Signal		

L.N.E. ENGINE Nº 3666 CLASS D 29	BRAKE THIRD Nº 3435	THIRD Nº 3081	COMPO Nº 3218	BRAKE THIRD Nº 3372	THIRD Nº 3085	BRAKE THIRD Nº 3046	COMPO Nº 3230	FISH VAN Nº 78505

COMPOSITION OF 2 P.M. DUNDEE TO GLASGOW TRAIN

L.N.E. ENGINE Nº 2734 CLASS K 3	THIRD Nº 3878	THIRD Nº 3079	BRAKE THIRD Nº 3291	THIRD Nº 3043	OPEN THIRD Nº 327	RESTAURANT CAR Nº 3986	FIRST Nº 3985	THIRD Nº 3939	BRAKE THIRD Nº 3006

COMPOSITION OF 4-3 P.M. EDINBURGH TO GLASGOW TRAIN

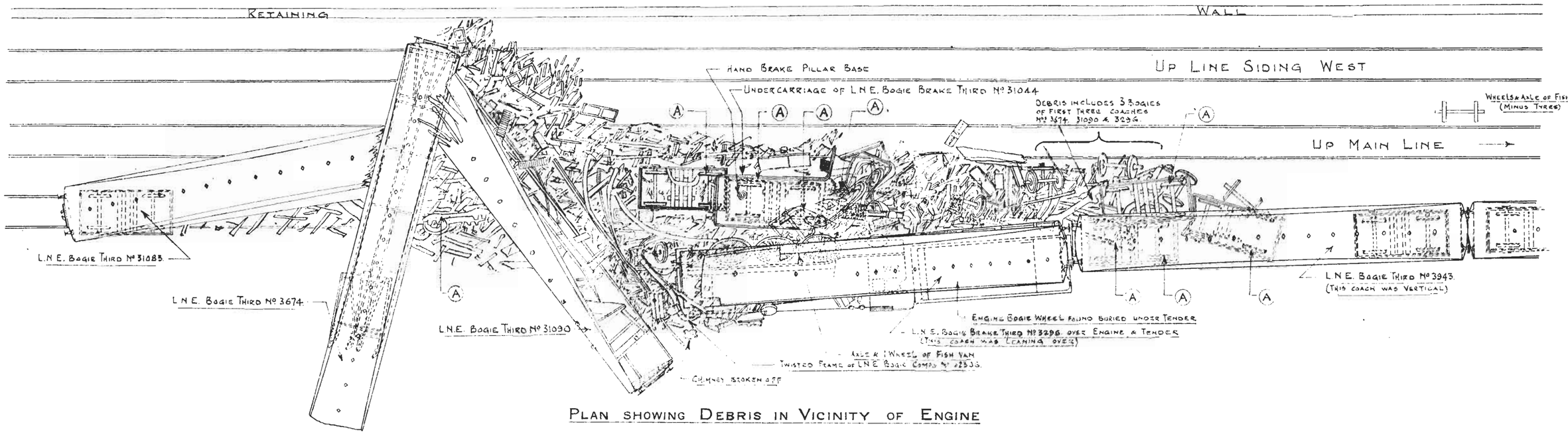


TRACK CIRCUIT INDICATOR - BANNER TYPE

FULL SIZE

COLLISION AT CASTLECARY 10TH DECEMBER 1937.

DRAWING "B"

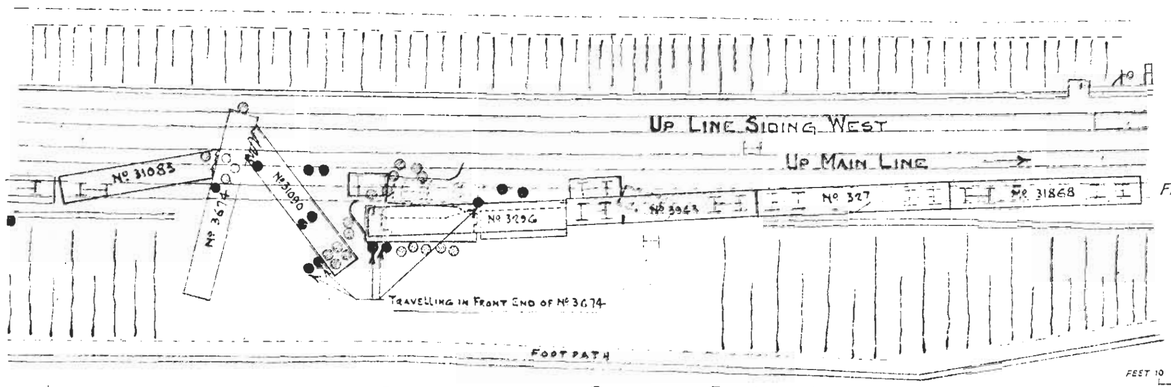


PLAN SHOWING DEBRIS IN VICINITY OF ENGINE

NOTE: POSITION OF WRECKED BOGIES INDICATED THUS (A)

SCALE (Approximate)

FT 10 5 0 10 20 30 40 50 FT



TO GLASGOW

FROM EDINBURGH

REFERENCE	
●	FATALITIES IN EDINBURGH TRAIN
©	FATALITIES IN DUNDEE TRAIN

PROBABLE LOCATION OF FATALLY INJURED PASSENGERS			
Bogie Third	31083	5	Dundee Passengers
Bogie Brk Third	31044	9	Do
Bogie Compo	32346	8	Do
Total		22	4 Women & 18 Men
Bogie Third	3674	6	Edinburgh Passengers
Bogie Third	31090	7	Do
Total		13	2 Women & 11 Men
Grand Total		35	(6 Women & 29 Men)

SCALE (Approximate)

FEET 10 0 50 100 150 FEET

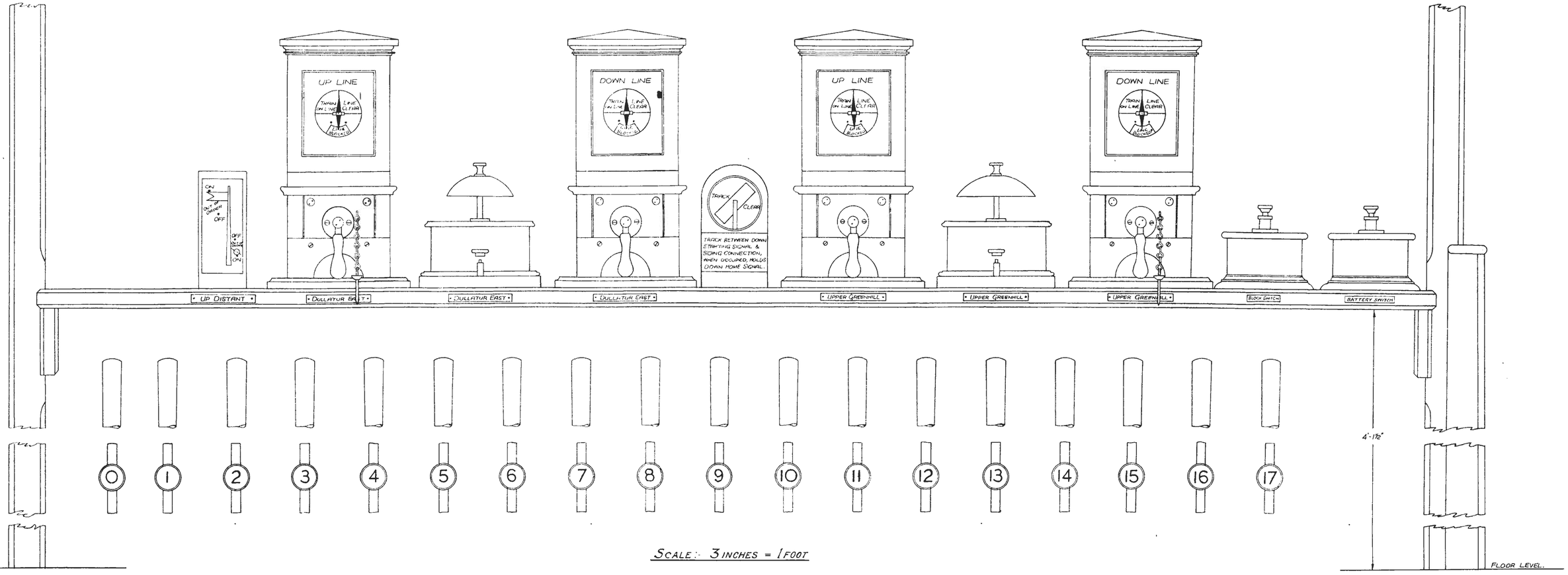
DIAGRAM SHOWING POSITION OF FATALITIES

324, 3074, 264-1000 (p) 346 M & S 8/33.

L.N.E.R. SCOTTISH AREA

CASTLECARY SIGNAL BOX — BLOCK INSTRUMENT SHELF AND INSTRUMENTS

DRAWING "C"

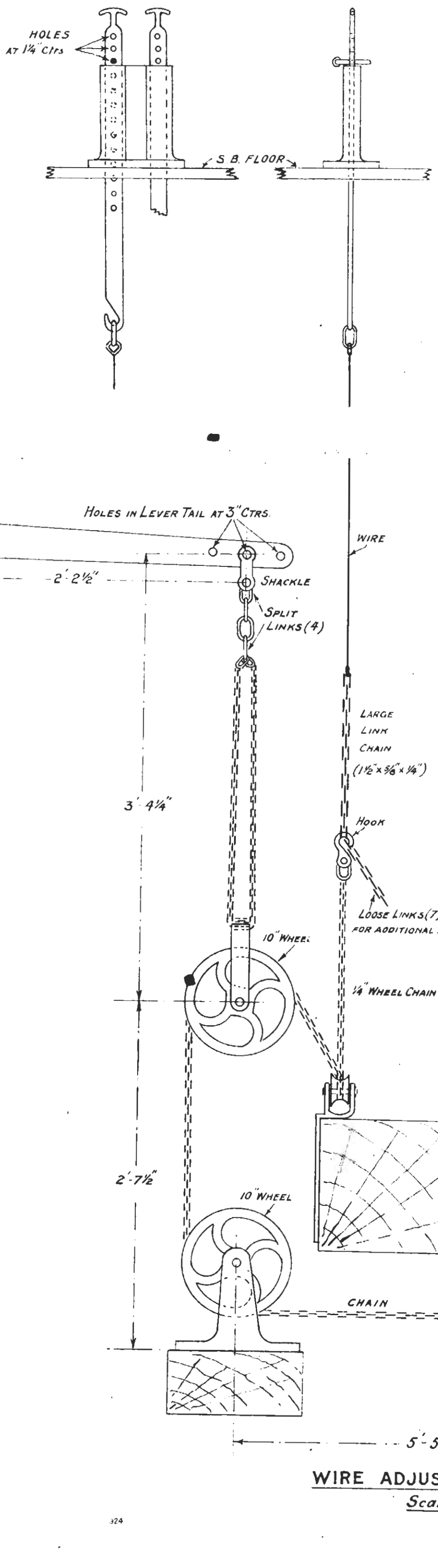


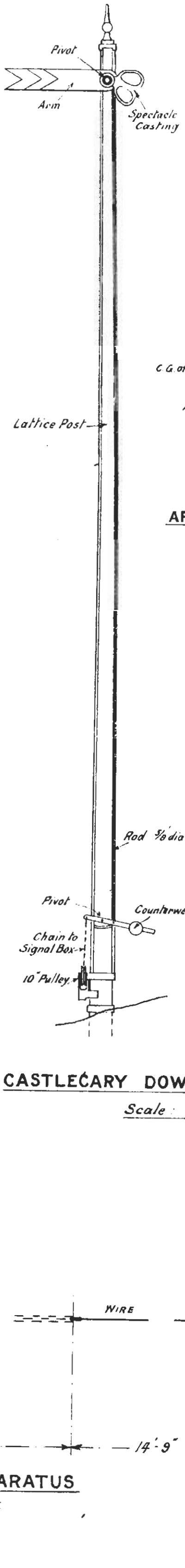
SCALE:- 3 INCHES = 1 FOOT

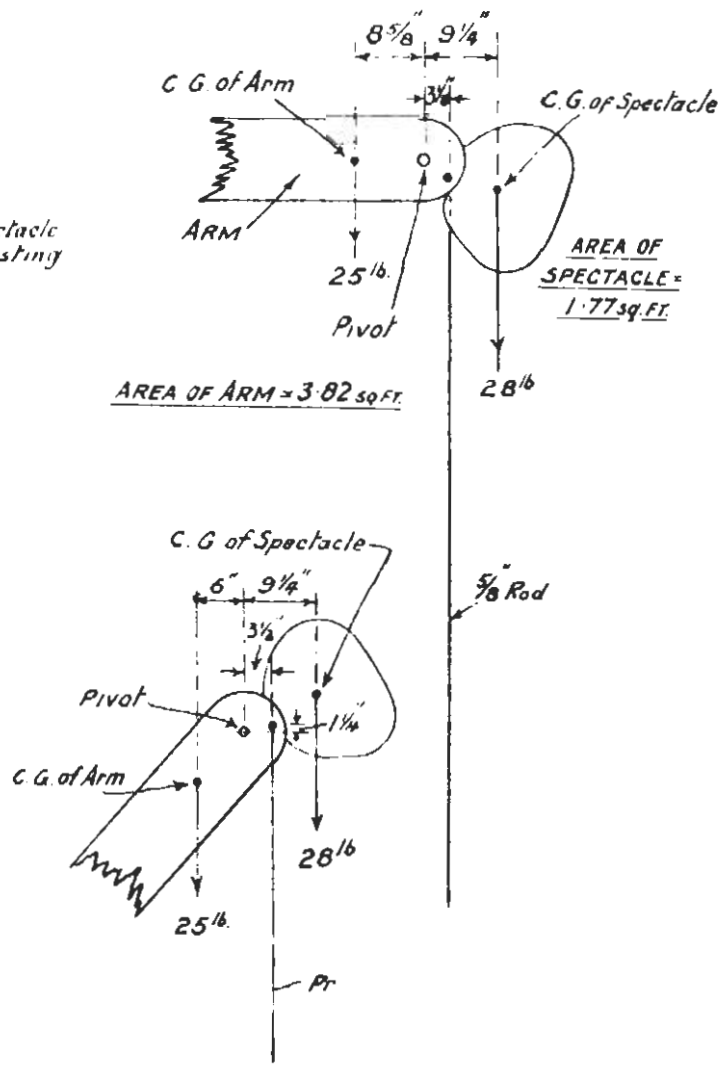
L.N.E.R. SCOTTISH AREA
CASTLECARY

DRAWING "D"

DOWN DISTANT SIGNAL AND WIRE ADJUSTING APPARATUS







ARM IN "OFF" POSITION

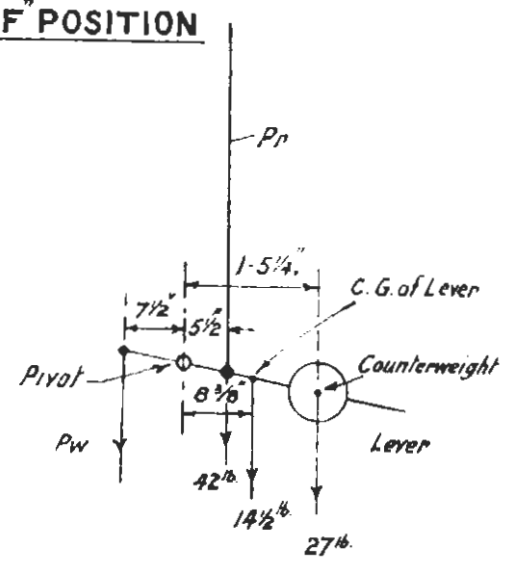


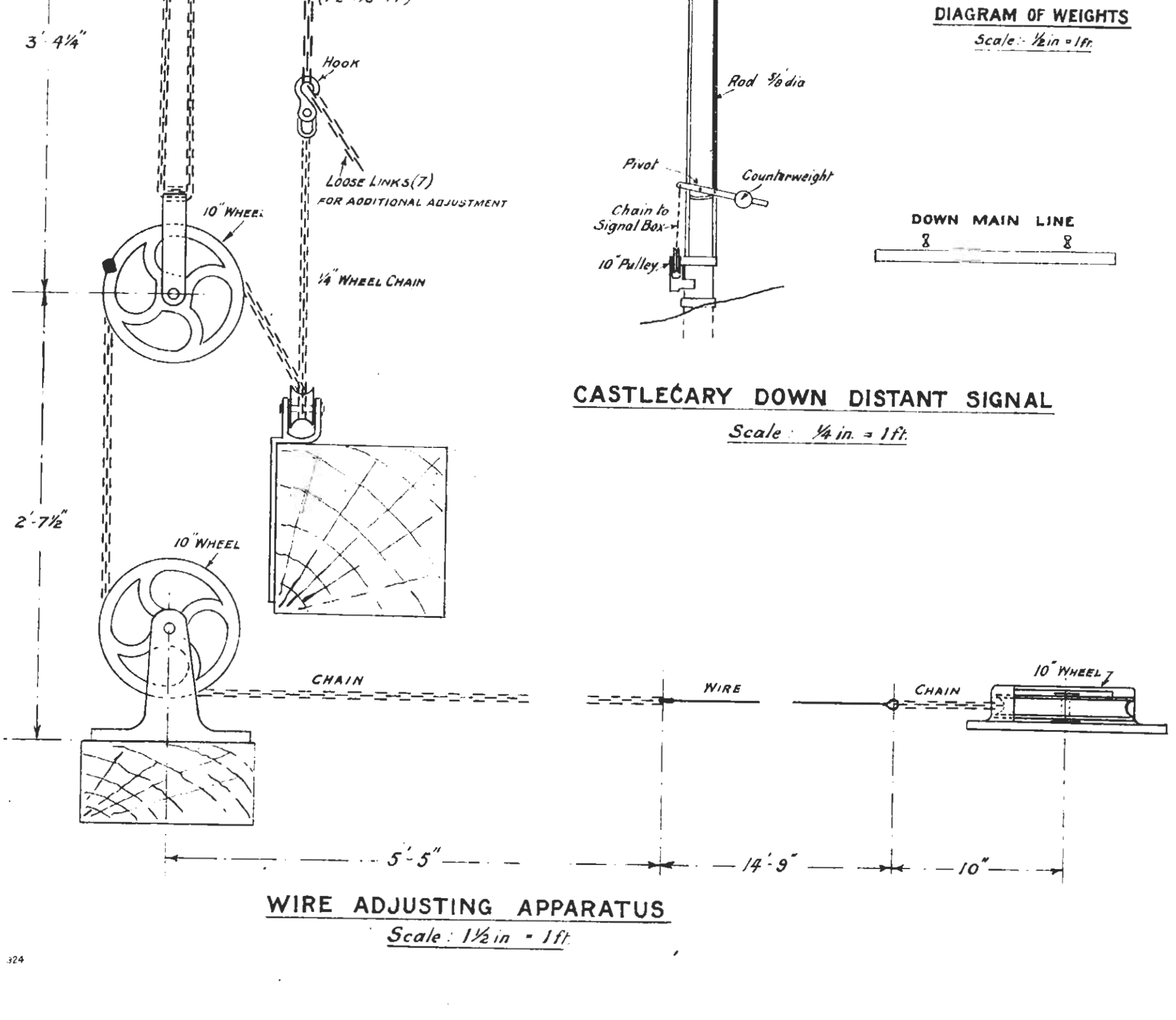
DIAGRAM OF WEIGHTS

Scale :- ½ in = 1 ft.

DOWN MAIN LINE

CASTLECARY DOWN DISTANT SIGNAL

Scale : ¼ in. = 1 ft.



WIRE ADJUSTING APPARATUS

Scale : 1½ in - 1 ft