



MINISTRY OF TRANSPORT

RAILWAY ACCIDENT

REPORT ON THE COLLISION

which occurred on

3rd June 1960

at

WATERLOO

in the

**SOUTHERN REGION
BRITISH RAILWAYS**

LONDON: HER MAJESTY'S STATIONERY OFFICE

1960

THREE SHILLINGS NET

SIR,

I have the honour to report for the information of the Minister of Transport, in accordance with the Order dated 8th June 1960, the result of my Inquiry into the collision between a steam hauled passenger train and an electric empty coaching stock train which occurred at 6.32 p.m. on Friday, 3rd June 1960, at Waterloo, in the Southern Region, British Railways.

2. The 6.14 p.m. Down steam passenger train from Waterloo to Weymouth which was well filled with Whitsun holiday traffic, left from No. 12 platform at 6.31 p.m., on a fine evening, with the route set to the Down Main Through line. It had travelled only some 280 yards when the 6.12 p.m. Up electric empty coaching stock train from Durnsford Road to Waterloo, on the Up Main Through line, came into facing sidelong collision with it. The latter train was destined for No. 6 platform; its route crossed that of the steam train and it was therefore to have been stopped at the inner home signal, but it passed that signal at danger. The trains struck each other offside to offside at a point 92 yards beyond the signal and near the converging junction on the paths of the two trains.

3. The leading motor coach of the electric train struck the fourth coach of the steam train and the electric train stopped immediately with the front half of the leading coach ripped away. The steam train however continued on its journey and the sides of all the coaches rearwards from the point of impact were damaged; many window lights were broken and doors and side panels were torn off or buckled. Neither train was derailed. There were 671 passengers in the steam train but fortunately, apart from a few cases of slight cuts or shock, there were no injuries. The motorman of the electric train also was uninjured. The steam train was stopped at Vauxhall, the next station, where the passengers were detained. They were returned to Waterloo in suburban trains and continued their journeys by subsequent main line trains.

4. The Assistant Station Master, Waterloo, was in the signal box at the time and saw the collision, and he promptly called for the ambulance and fire services. These arrived within a few minutes but their help was not required. Fallen metal from one of the trains caused a dead short circuit between the conductor rail and the running rail which automatically cut off the traction current to the lines concerned.

5. The electric train was removed and the Up and Down Main Through lines were re-opened to traffic at 8.15 p.m. after they had been examined and tests had been carried out, but these and other lines were re-closed subsequently for various periods to enable further tests to be made on the signalling equipment. Very considerable delays were caused to the train service generally.

DESCRIPTION

The trains

6. The 6.14 p.m. steam train from Waterloo to Weymouth comprised eleven coaches and it was hauled by a Merchant Navy class engine, driven from the left hand side.

7. The 6.12 p.m. electric train from Durnsford Road to Waterloo comprised 12 coaches of main line corridor stock. The motorman's position was on the left hand side of the leading cab.

The site

8. Waterloo is the London terminus of the Western Section of the Southern Region and it has 21 platforms. Nos. 1 to 4 and Nos. 17 to 21 are used only for suburban trains; Nos. 5 to 16 are used chiefly for West of England main line steam trains and Portsmouth, Guildford via Effingham Junction (known as the New Guildford line) and Alton electric trains, though suburban trains are regularly taken into some of them. Between Waterloo and Vauxhall, approximately one mile to the South, there are four Up and four Down lines. From West to East they are the Up Windsor, Down Windsor Through, Down Windsor Local, Up Main Relief (U.M.R.), Up Main Through (U.M.T.), Down Main Through (D.M.T.), Up Main Local and Down Main Local. For simplicity's sake the above initials will be used in this report. The lines curve considerably and approaching the terminus the Up lines take a long left handed curve, the latter part of which is of 14 chains radius, followed immediately by a 7 chain radius right handed curve into the station. Details of these lines, of the layout of the tracks at Waterloo and of the position of the signals concerned are given in the attached plan. The gradients are shown on the plan, but they are of no account.

The signalling equipment

9. The lines between Waterloo and Vauxhall are fully track circuited and the signals are 3-aspect or 4-aspect multiple lens colour lights. They and the electrically operated points are controlled from an electrically interlocked frame with 309 miniature levers, 272 of which are working levers, situated on the upper floor of the two storey signal box at Waterloo; the relay room, battery room, transformers, rectifiers, etc. and the linemen's rooms are on the ground floor. The position of the box is shown on the plan.

10. The frame in the signal box is arranged to form three sides of a rectangle. There are four illuminated diagrams each covering all the tracks between Vauxhall (inclusive) and Waterloo; one diagram is above each short section and two are above the long section of the frame. The occupation of a track circuit is indicated by the illumination of two red lights on the diagrams. All the aspects of signals are repeated above the levers in the frame except that, when a signal is controlled by more than one lever, the repeater lights are provided only above the two end levers. There is an indicator light with the letter "F" above each signal lever; when illuminated it indicates that the route is correctly set and locked and that all the detection circuits are made, and that, consequently, the lever is free to be reversed. When the lever has been reversed and the aspect of the signal has cleared, another light above the lever becomes illuminated and indicates the route which has been set up. There are also two indicator lights above each lever controlling points in a running line, with the letter "N" (normal) in one and "R" (reverse) in the other. When illuminated they indicate the position of the points and also that the detection circuit is made.

11. There is a "train ready to start" plunger on each platform which, when operated, illuminates a light in the signal box and indicates, as its name implies, that the train on the particular platform to which the light relates, is ready to start.

12. There are no block instruments and trains are described between Waterloo signal box and Loco. Junction signal box, the next box which is just under 2 miles distant. The frame is operated in each shift normally by four signalmen and in addition there is a Yard Inspector, who is in charge; there are also two booking lads. Signal linemen are on duty throughout the 24 hours.

13. All the running signals that lead to more than one route are equipped with multiple lamp theatre type route indicators, except signal No. 77/83 on the Up Main Through line at Vauxhall which has a position light junction route indicator; this signal leads along the Up Main Through (U.M.T.), which is the "straight" line and, with the Junction indicator illuminated, over points No. 84 reversed along the Up Main Relief (U.M.R.). On account of the curvature the starting signals on platforms 9-16 have banner repeaters and every platform has an indicator in which the word "off" becomes illuminated when the signal is clear.

14. The signals with route indicators or junction indicators are each worked by more than one lever, depending on the number of routes to which the signal leads; for instance, signal No. 77/83 mentioned above is worked by either lever No. 77 or No. 83. Signal No. 101-116, mentioned below, is worked by any one of 16 levers. In the Up direction the lowest number applies to the furthest route to the right and the highest number to the furthest route to the left. In the Down direction the reverse is the case.

15. The signalling equipment was brought into use in 1936.

16. The signals referred to in this report are given below. For the sake of simplicity each signal is given a letter and will be referred to by that letter; the letters are used in the plan.

(i) *At Vauxhall*

A. No. 77/83 Leads to signal B on the U.M.T. and signal E on the U.M.R.

(ii) *On the Up Main Through (U.M.T.)*

B. No. 78 Leads to signal C on the U.M.T.

C. No. 79-81 The outer home signal. Leads to signal D on the U.M.T., to signal G on the U.M.R. and to the Up Windsor line.

D. No. 101-116 The inner home signal. Leads to No. 1 to No. 16 platforms. The levers to clear the signal for No. 6 and No. 14 platforms are No. 106 and 114 respectively.

(iii) *On the Up Main Relief (U.M.R.)*

E. No. 86 Leads to signal F on the U.M.R.

F. No. 88-90 The outer home signal. Leads to signal G on the U.M.R., to signal D on the U.M.T. and to the Up Windsor line.

G. No. 118-126 The inner home signal. Leads to platforms No. 8-16. The lever to clear the signal for No. 14 platform is No. 124.

(iv) *On No. 12 platform*

H. No. 186 The starter. Leads, when preceded by lever No. 185, along the Down Windsor Local and when preceded by lever No. 184 to signal J on the D.M.T.

(v) *Down Main Through (D.M.T.)*

J. No. 153-156 The advanced starter. Leads along the Down Main Local, D.M.T. Down Windsor Through and Down Windsor Local.

(vi) *On No. 21 platform*

K. No. 285/286 The starter. Leads along the Down Windsor Local and Down Windsor Through.

17. Except for signals A, H and K, which are on posts by themselves, all the signals mentioned above and their route indicators are on gantries spanning the tracks. Every signal is just to the left of the line to which it refers and the route indicator is to the left of the signal.

18. On account of the curvature the sighting of some of the signals, particularly the inner homes, is restricted and difficult. From the cab of an electric train on the U.M.T., signal C can be seen at a distance of 172 yards (point X on the plan) and, provided there is no train on the U.M.R., signal D at 130 yards (point Y on the plan); on account of the advanced starter gantry, however, signal G on the U.M.R. comes into view about 5 yards before signal D on the U.M.T. Also on account of that gantry, the guard of a train on the U.M.T. can, through the periscope, first see signal G at a distance of approximately 125 yards and then signal D at 110 yards.

The signalling controls

19. As with mechanical interlocking, the electrical interlocking prevents the levers of signals controlling conflicting routes from being reversed at the same time. The electrical locks and contacts are on shafts which are connected physically to the levers; they are located behind the frame and are enclosed by steel panels which are kept locked.

20. The track circuits exercise the usual controls on the signals and points. They ensure that the aspect of a signal is held at red by the occupation of any track circuit in the route which the signal controls up to and including the overlap track circuit beyond the next signal ahead. There is however an exception to this in the case of inner home signals. There are two track circuits on each platform line; when both are unoccupied the inner home signal will clear to Green; it will also clear when the further track circuit is occupied and the nearer one is unoccupied, but only to Yellow. The track circuits also approach lock and back lock signals, and lock points in the route of a train. When a route is set up and the signal for that route is cleared, and when the approach locking track circuit is occupied by the train, the signal lever is back locked until the train has reached a certain track circuit ahead of the signal. The lever can then be replaced to its normal position but the route remains locked up to and including the overlap track circuit beyond the next signal ahead or, in the case of an inner home signal, up to the platform line. The occupation of a certain track circuit beyond a signal replaces the aspect of the signal to Red. The occupation of a track circuit also directly locks all facing and trailing points which lie on it in either the normal or reverse positions, according to the way in which they are set.

21. There are no releases for the track circuit locks. A lineman must be called and he must unlock the back of the frame and remove a panel to get access to the electric locks. He can then free a track circuit lock on a lever by the simple motion of lifting the lock. In order, however, to release the lever interlocking he must first break a seal; this is an extremely infrequent occurrence and needs to be done only during alterations to the interlocking or in the event of a fracture of a lock. All releases given by linemen are required to be noted in a special register and the entry must be signed by the lineman concerned and by the person at the time in charge in the box.

22. Electric detection is provided on all facing and trailing points on running lines to prove that the switch blade is hard against the stock rail and, in the case of facing points, that the points are properly locked, before the lever of the signal concerned can be released. The detection is set to a fine limit (it will break at $\frac{1}{16}$ in.) and it can sometimes be upset by men working on the track nearby or by the vibration caused by a train on an adjacent track. If a signal has been cleared and the detection of points on the route of the train or of "trapping" points on an adjacent route becomes upset, the signal will change to Red. When this occurs, or when a "bobbing" track circuit in the controlled route of a train replaces a clear signal to Red, the signal will stay at Red until the controls are correct and the signal lever has been replaced and re-pulled.

23. Details of the relevant electrical lever locking, direct track circuit controls, approach locking, back locking, route locking and of the electrical detection of points, in connection with signals D and H are given in the Appendix.

24. The signalling circuits are operated by 110 volt A.C.; the current supply for the signals is also 110 volt A.C. up to the signal cabinets where it is transformed to 12 volt A.C. 50 volt D.C. is used for the route indicators and 130 volt D.C. for the point machine motors. The track circuits are of the single rail A.C. type.

25. On account of the slow speed of trains approaching and leaving the terminus and of the closeness and complexity of the layout at Waterloo, the overlaps beyond signals are short. The overlap beyond signal D is 77 yards. Overlaps are however provided to prevent accidents occurring from misjudgment in braking a train, and not from the disregard of signal aspects.

THE COURSE OF EVENTS

26. On account of the heavy traffic there was delay at Waterloo to the 6.14 p.m. Waterloo to Weymouth Down train, and the "ready to start" indication for it was received in the signal box at 6.30 p.m. from No. 12 platform; the route was then set up for it to proceed to the D.M.T. and signals H and J were cleared. At that time the descriptions of the 6.12 p.m. Up electric and a steam train, the 3.0 p.m. Up Bournemouth to Waterloo, had already been received from Loco. Junction box. The electric train passed Vauxhall at 6.28 p.m. and proceeded towards Waterloo on the U.M.T. The steam train passed Vauxhall at 6.31 p.m. and was diverted to the U.M.R. because it was to be taken into No. 14 platform and its route was parallel to the route of the 6.14 p.m. Down train and both could be set up simultaneously. The 6.12 p.m. Up electric train was however to be taken into No. 6 platform. Its route therefore crossed the route of the Down train and consequently it was to be stopped at signal D. The signalling equipment allowed it to be brought up to that signal with the crossing movement set up, and this was done, but the electric locking and controls prevented the signal being cleared. As already mentioned, however, it passed the signal at danger.

27. Approaching Waterloo the Up steam train on the U.M.R. was some way behind the Up electric train on the U.M.T. The driver of the former train saw signal G showing a green aspect with a route indication to No. 14 platform and he proceeded into that platform. Neither he nor the fireman were aware of the collision until later. The guard had also seen signal G at Green and the figure 14 in the route indicator.

28. The driver and fireman of the 6.14 p.m. Down train to Weymouth both saw signal H at clear. They were unaware of the collision until later. The guard was travelling in the ninth coach and felt the impact. After that coach had passed the point of impact he looked out and saw that the train was damaged but not derailed and he considered it safe to allow it to proceed to Vauxhall where the passengers could be detrained more easily, and he stopped it at that station by an application of the brake valve in his van.

29. After the collision, the track was found undamaged and crossover No. 132 was found correctly set in the reverse position for the passage of the 6.14 p.m. Down train. It was electrically locked because the 6.12 p.m. electric train was occupying track circuit DX in which the station end crossover points lie, and the electric lock had to be released and the crank handle used to set them normal for the disposal of the electric train.

EVIDENCE

30. Signalmen J. R. Edwards and R. A. Attfield were on duty in Waterloo box. Edwards was signalling trains from the platforms to the D.M.T. and from the U.M.T. and U.M.R. lines to the platforms, while Attfield was signalling trains on the U.M.T. and U.M.R. lines. As mentioned earlier the 3.0 p.m. train was diverted to the U.M.R. at Vauxhall. This was done by Attfield, and Edwards cleared signal G for it to enter No. 14 platform. Edwards saw that the repeater lights of signal G were green and that the number 14 had appeared in the indicator above No. 124 lever. He had previously cleared signals H and J for the 6.14 p.m. train to leave No. 12 platform to the D.M.T. and he saw that their repeater lights were green.

31. The signalmen had agreed between themselves that the 6.14 p.m. Down train should leave before the Up electric empty train was taken into No. 6 platform, and they both said that signal C was held at Red for some time to check the latter train; in fact, they thought it probable that the train had stopped before the signal was cleared to allow it up to signal D. Both signalmen said they saw that the repeater light of the latter signal was red.

32. Mr. F. E. Taylor was the Yard Inspector in charge of the Waterloo signal box. He had given instructions for the 6.14 p.m. train to be despatched from No. 12 platform and he said that that automatically meant that the 6.12 p.m. Up empty electric train would be stopped. He saw that the repeater lights for signals G and H were green. He was talking to Mr. Sprague, the Assistant Station Master, when he heard Edwards shout that the Up electric train had run past signal D and he turned round and saw that train strike the 6.14 p.m. train as it was leaving. He saw at the same time that the repeater light of signal D was red. He at once examined the positions of the points levers and found that they were correct for the route set up for the 3.0 p.m. Up and 6.14 p.m. Down steam trains; he also saw that the lever of signal D was normal.

33. Mr. Taylor and the two signalmen were all definite that there was no lineman in the box at the time and also that no back lock release had been given during their shift which had started at 1.0 p.m.

34. Driver C. E. Short and Fireman A. M. White of the 6.14 p.m. train to Weymouth both confirmed that signal H was green and that the route indicator showed M.T. (Main Through) when

they started. In fact, Short had specially drawn White's attention to the signal and the indicator, because it was the latter's first trip to Waterloo. Guard R. Webb of that train did not see signal H but he saw from the indicator on the platform that it was "off".

35. Station Foreman W. E. George was on duty on No. 12 platform and operated the "train ready to start" plunger for the 6.14 p.m. train to Weymouth. From the position in which he was standing he could not see the starting signal, but he did about one minute later see the indicator and the banner repeater come "off", and he then gave permission to the guard to start the train. Leading Porter H. E. Warner was also on duty on No. 12 platform and was at the country end of it, and he saw signal H change to green.

36. Driver E. Doust of the 3.0 p.m. Bournemouth to Waterloo train said that signal A was yellow and the junction route indicator was illuminated which indicated that his train was to be diverted to the U.M.R. line. The next three signals, E, F and G, were green and there was a route indication to No. 14 platform with signal G. Guard P. J. Ellement confirmed that statement. Both Doust and Ellement said that they had not noticed the aspects of any signals on the U.M.T. line.

37. Motorman S. A. Perry, of Wimbledon Depot, was the driver of the 6.12 p.m. Up empty electric train. He said that while waiting to come out from Durnsford Road Depot he saw a train pass on the Up Through line and recognised it as a New Guildford line train. Shortly afterwards the outlet signal was cleared for his train to pass on to that line. He said that he followed the New Guildford line train the whole way to Waterloo, and saw that every signal was yellow for his train until he saw signal D which was green. His own account of subsequent events was as follows. "When I came in sight of W.B. 101 (signal D) I saw that it was green, and I also saw in the platform indicator "4" and when I got further round the bend I saw also a "1" which was platform 14. When I saw the yellow at West Crossings (signal C) I brought my train under control, applying the brake a little, expecting to be stopped at the next signal. When I saw it was off I released the brakes and I also saw the tail part of the train in front still going into the station, and something crossed my mind that it was funny that the signal had come off rather quickly if that was the case and I felt a little uneasy. It is through experience that you get these feelings. I glued my eye to my signal for that one reason. I don't know why, but I just did and I even kept my eye on it to the extent that I bent down to see it go over the top of my head. I looked down on to the track and I had the biggest shock of my life to see that the steam train was across my path so I immediately applied my brake and was on the verge of stopping when I had the collision."

38. Perry was certain that signals A, B and C were all yellow and that signal D was green when he first saw them. He was most emphatic about the aspect of signal D and its route indication to No. 14 platform. He had not noticed signals E and F, and he was certain too that he had not seen signal G. When it was pointed out to him that signals G and D come into sight practically simultaneously (in fact G comes into sight slightly before D), he said "I quite agree with you, and if I had been in my regular frame of mind I would have seen these two signals but as I say I was uneasy about the signal coming off quickly—I don't know what it was, but I just felt something was wrong, so I just glued my eyes to my own signal which was the Up Through. I did not look at any other colour light signal at all."

39. Perry estimated that, approaching signal C, the speed of the train was 25-30 m.p.h. He had already shut off power and near that signal he made a slight brake application, anticipating that signal D would be red. He said that when he saw that signal was green it was unnecessary to re-apply power because the speed was sufficient to carry the train into the platform.

40. Perry stated that he had on many occasions worked trains on the U.M.T. and U.M.R. lines but that he had probably not done so for the week before the accident. When working trains on either of these lines he had never felt himself to be even momentarily in doubt as to which line his train was on, and he said that he was certainly in no doubt that the 6.12 p.m. train was on this occasion on the U.M.T.; he was also quite certain that he had not seen signal G at green (which it was) with a route indication 14 (which it had) and mistaken it for signal D. He went on to say that he identified the signal applicable to his train among others on a gantry by looking from right to left, even though the signal to the right of signal D was at least twice as far from it as was signal G.

41. Perry was questioned closely about the aspects of signals C and D but he was certain they were yellow and green respectively when they first came into view. He was also questioned closely about his statement that he caught a glimpse of the rear end of the train ahead of him going into a platform; this he said was a second or two after he had seen signal D at green. He stated that the train went into No. 4, 5 or 6 platform and that, when he saw it, about 3 coaches had not reached the platform. Perry agreed that he had on many occasions, after having yellow aspects at signals A, B and C, seen signal D at green when it came into view, but he insisted that it was because he saw the rear end of the train ahead on this occasion that he became uneasy (he said later that the expression "surprised" might be more appropriate), and "glued his eyes to signal D".

42. Perry stated that after the collision had taken place and the 6.14 p.m. steam train to Weymouth had passed, he got down from the cab. He soon saw the Assistant Station Master coming towards the train. Perry continued "When he reached me he asked me how I was, name, depot and what train it was and then I remarked to him 'What the devil has gone wrong?'

Without any hesitation he turned round and told me the steam train had 'run by'. He contradicted that remark some time later on. He went away, and I don't know how long it was, but later he came back to me and said the signaller had told him that I had 'run by'." Perry added that he himself did not go back to look at signal D and said "it would probably have gone back to red in any case because I (meaning his train) was over the track (circuit)". When the guard arrived Perry asked him if he had seen the signal and the guard replied that it was green but that he had not seen the route indicator.

43. Perry said that a year or two ago he had experienced a wrong indication when running into Waterloo on the Up Windsor line. The Route Indicator had shown 21 but the train was taken into platform 20. He reported the matter to the signaller but he did not make a report on his return to the depot. He went on to say that he had not much confidence in the signalling equipment at Waterloo and that other motormen also thought that there was something wrong. He quoted two previous cases of motormen having been accused of passing a signal at danger when they were certain that they had not done so. One was a case in which a driver of a train was alleged to have passed signal K at red. It is referred to later in paragraph 49.

44. Guard L. Walsh was travelling in the eighth coach, a brake van, of the 6.12 p.m. train. He said that he was observing signals through the periscope and saw signals A, B and C were yellow and D was green when they came into view; having seen signal D he did not keep it in view. He said that he did not observe the signals on the U.M.R. Walsh thought that Perry might have made a slight brake application at signal C but that the train certainly did not stop there. He also thought that the speed of the train was normal with signals at caution.

45. Mr. R. H. Sprague, Assistant Station Master, Waterloo, said that he was in the signal box at the time of the accident and actually saw it take place. He immediately arranged for the emergency services to be called, and advised the station staff; he then went to see if the motorman of the electric train was injured. He denied emphatically that he had told the motorman that the steam train had passed a signal at danger. He said that he realised that either the steam train or the electric train must have passed a signal at danger, but that at the time he did not know which had done so. Later, when he had obtained further information, he told Perry that he had run past a red signal and asked him whether he wished to say anything, but Perry replied "Not at this stage".

46. Lineman H. Glen, another lineman and two assistant linemen were in their mess room having a late tea when at 6.37 p.m. they were informed there had been an accident. Glen went to the site and found that there was no damage to the signalling or points equipment and that points No. 132 were reversed. He then returned to the signal box and carried out tests on signal D and its route indicator and on the interlocking between signal D and points No. 132. He found everything in order. The electric train was standing on track circuit DX so he had to release the electrical locking on points No. 132 before he could use the crank handle to set them normal to enable the electric train to be taken into a platform. He and the other linemen had come on duty at 2.30 p.m. and, because the afternoon was fine, they had taken the opportunity of cleaning the shunting signals.

47. Mr. A. J. V. Hogger, a temporary sub-inspector who is responsible for the equipment in Waterloo signal box, arrived there at 7.50 p.m. He learned from Glen that certain tests had been made and he also made the same tests on signal D and points No. 132, and also a number of others. All the results were satisfactory. He examined all the relays in the circuits and found them in good order and he made tests to ascertain whether any extraneous current was being fed to these relays but found there was none. He also made resistance tests on all the circuits concerned and found that the insulation was good. Mr. Hogger stated that in making these tests his aim had been to find any fault which could possibly lead to a false clear indication.

48. In view of the positive statement by Motorman Perry that signal D was green with a route indication to No. 14 platform for his train and of the doubts cast by him and, according to him, by other motormen on the integrity of the signalling at Waterloo, I decided to adjourn the Inquiry to enable tests to be made.

THE TESTS

49. In view of the importance I attached to the tests I asked Colonel W. P. Reed to assist me. The object of our tests was to find out whether there were any circumstances at all in which a signal could give a false clear aspect or in which the signals for conflicting movements could be cleared at the same time. The scope of our tests covered the routes from signal D and signal G to No. 14 platform, signal H to the D.M.T. and, in view of Motorman Perry's allegation in paragraph 43, signal K to the Down Windsor lines.

50. Before describing the tests which we made it is necessary to amplify the general description of the electrical locking and controls which has been given in paragraphs 19-23. As mentioned, details of the relevant locking and controls on signals D and H are given in the Appendix, in which there are three tables. Table I shows the electrical lever locking, Table II the electrical controls and detection and Table III the electrical route locking. The subsidiary signals have been ignored except those which form an integral part of the locking of a running signal.

51. Table I shows the levers which must be reversed before a lever can be released from its normal position, and the levers which it locks when it has been reversed. It will be seen that in order to release lever No. 114 (controlling signal D to No. 14 platform) lever Nos. 150, 146, 137 and 136 must first be reversed; when lever No. 114 has been reversed it locks those levers in the reversed position and it also locks lever Nos. 132, 133, 147 and 237 in the normal position; again, when points lever No. 132 has been reversed, and it must be reversed before lever No. 186 (which controls signal H to the D.M.T. and is released by lever No. 184) can be reversed, it locks lever No. 114. It is therefore clear that the locking prevents signal D from being cleared for a movement to No. 14 platform at the same time that signal H has been cleared for a movement to the D.M.T. It will in fact be seen that, when the latter signal has been cleared, the locking prevents signal D from being cleared for a movement to any platform; the converse is also the case.

52. Tables II and III show that lever No. 184 detects points No. 132 reversed. That lever, through lever No. 186, is approach locked by the train occupying platform track circuits DL and DM and it is back locked until track circuits DN, DG and DF have been occupied and cleared or until DY has been occupied. When the back lock has been released the lever of points No. 132 would be free to be moved but the route lock is then applied by the occupation of track circuit DY, and when that track circuit has been cleared the points are held directly by track circuits DX and EX. It will thus be seen that once signal H has been cleared the controls prevent points No. 132 being moved from the reversed position until the train has passed beyond track circuit EX. In the same way it will be seen that once lever No. 114 (signal D) has been reversed and the approach locking track circuit DW, which starts 113 yards on the approach side of signal D, has been occupied, the route into the platform is held. Points No. 132 need to be normal for this movement and the controls prevent them being reversed until the train has passed beyond track circuit DX.

53. Before making the tests we had the circuits explained to us in detail and we were satisfied that they are designed to fail to safety. Any disconnection of a lead to a relay or other terminal, the breakage of a wire or cable, the "bobbing" of a track circuit or the upsetting of a detection circuit will prevent a clear aspect appearing in a signal or, if it has appeared, will cause it to change to a danger aspect. We also saw that the repeater lamps above the signal levers are in series with the signal lamps and that it is therefore impossible for the aspects of these to conflict with each other. In addition the equipment in the signal box and relay room, and outside, was examined.

54. We then carried out extensive tests at night after the passenger traffic had stopped. We tested the electrical lever locking, the electric controls and detection, and the route locking on all the routes mentioned in paragraph 49, and on some other routes. In addition we did a number of further tests which are described in the next paragraph.

55. As a result of these tests, Colonel Reed and I were satisfied beyond all doubt that the equipment which we tested was in proper working order. Consequently, when I re-opened the Inquiry in public on 15th July, I made the following statement:

"In view of certain statements regarding the integrity of the signalling at Waterloo which were made when I opened my Inquiry on 15th June, I adjourned to carry out detailed tests on the signalling. Considerable importance was attached to the tests and consequently I was accompanied by Colonel Reed, another Inspecting Officer. The tests were made not only on signal No. 101-116, the Up Main Through home signal concerned in this case, but also on signal No. 285/286, the starting signal from No. 21 platform, which was concerned in a previous case which was mentioned by Motorman Perry in his evidence.

Colonel Reed and I took the opportunity of inspecting various parts of the electrical interlocking equipment and the relay room, including the electrical locking and the relays of both the signals mentioned above. We found the electrical interlocking equipment to be in excellent order and the relay room well laid out, clean and well maintained.

The tests included the complete checking of the electrical locking on all the signal and point levers concerned, the approach locking and back locking of the signal levers, and the direct holding of points and route holding by track circuits, and also the detection circuits of all the points concerned, both in the direct route of the trains and in the adjacent routes. They were made on the routes concerned in both the cases mentioned above and on routes which conflicted with them.

The tests we carried out showed that, unless there was deliberate interference with the equipment, signal No. 101-116 on the Up Main Through line could not have shown a green aspect with a route indication for platform No. 14 when a route was set for a train on the Up Main Relief line to enter No. 14 platform, or for a train to leave No. 12 platform. The tests also showed that signal No. 285/286 could not have shown a green aspect unless the route had been correctly set for the train to proceed from No. 21 platform to one of the Down running lines.

We were entirely satisfied that a false green aspect and a false route indication could not possibly have been given in these cases. They can be given only by the cross connection of certain terminals on the equipment or by extraneous currents finding their way into the particular circuits concerned on account of faulty insulation.

The cross connection of two particular terminals in a signal relay will give a false green aspect in the signal, but it will not extinguish the red aspect. For this to be done it is necessary for two other particular terminals of that or another relay to be connected together. We were entirely satisfied that neither of these two connections could be made accidentally by the placing of any tool on the relays; we were also fully satisfied that a relay could not be actuated accidentally by a testing lamp (See Note (i)).

A false route indication can be given by the cross connection of certain terminals in the electrical interlocking equipment, which necessitates opening up the back of the frame; for a false indication to be given to No. 14 platform, two connections would have to be made because there are two digits in the number.

For a false green aspect to appear in a signal, the red aspect being extinguished, and for a false route indication to appear together, all these connections would have to be operative at the same time. They could be made only by a lineman with expert knowledge of the equipment, and his actions in making them would be not only in deliberate disregard of his training and code of behaviour, but they would amount to nothing less than sabotage; you will agree with me that this is unthinkable. Apart from this, however, I am satisfied from inquiries I have made that at the time of the present accident there was no lineman in the relay room or on the operating floor of the signal box, and that the back of the frame was not open.

The other possibility of a false aspect and indication being caused by extraneous currents would necessitate these currents finding their way simultaneously, and at the particular moment when the train was approaching, into three separate circuits (See Note (ii)), and at the same time a cross connection would be necessary on the signal relay to extinguish the red aspect. You will agree with me that it is beyond the bounds of all chance for this to have occurred.

Nevertheless, while the tests were being made, a voltmeter (See Note (iii)) was placed across the terminals of the relays of the signals concerned in this case and in the previous case, when conflicting movements were being set up, in order to ascertain whether any extraneous current at all was being fed to the relays, but no voltage was registered. In addition I have asked for proving circuits to be provided on certain signals at Waterloo. These circuits will incorporate a stick relay which will be sealed and that relay will give an irrefutable indication if at any time at all, whether a train is approaching a signal or not, a signal gives a clear indication when its lever is normal.

In addition to the tests and examinations I have already mentioned, Colonel Reed and I witnessed resistance tests on the circuits of the signal concerned in this accident (See Note (iv)). The tests were made between the conductors and earth, and between the conductors themselves. In every case the reading showed that there was no fault whatever in the insulation. I also had the entire length of the cable run to signal No. 101-116 uncovered, and I examined it carefully. I also examined the signal and the route indicator on the gantry. I found no defects.

In this statement I have referred to a "false clear aspect", or in other words, to the case of a signal showing a clear aspect when it should be showing a danger aspect. All signalling circuits are designed to "fail to safety". If a signal has been cleared for a train and a fault develops anywhere in the circuit of that signal, the signal will automatically change to red. Faults of this type are not altogether uncommon, and the most usual type of fault to cause a clear signal suddenly to change to red is the upsetting of the detection, which is set to a fine limit, of a set of points in or leading to the route, by the vibration of a train on an adjacent line. Signal circuits are designed to ensure that a signal will when necessary change from clear to red and that it will *never* incorrectly change from red to clear.

In conclusion I would say that Colonel Reed and I were satisfied beyond all doubt with the integrity of the signalling equipment at Waterloo Station which we tested. We have no doubt whatever that the rest of the signalling at Waterloo is in as good condition. This being the case, Up Main Through signal No. 101-116, could not have shown a green aspect with a route indication to No. 14 platform for the 6.12 p.m. train from Durnsford Road to Waterloo on 3rd June when the route was set for the 3.0 p.m. Bournemouth train to run from the Up Main Relief line to platform No. 14 or when the route was set for the 6.14 p.m. Down Weymouth train to leave from platform No. 12. That the routes were so set for these two latter trains is not a question of speculation; it is a fact. Similarly, signal No. 285/286 could not have shown a clear aspect for a train to leave platform No. 21 with the points at the end of the platform wrongly set."

Notes

- (i) The testing lamp is covered with a cage made of non-conducting material, and the resistance of the lamp is 195 ohms; an electrical pressure of not less than 60 volts is required to actuate a relay.
- (ii) The false feeds would, if they were to have any effect, need to be at approximately the same voltages as those used in the circuits (see paragraph 24).

- (iii) The voltmeter which was used was a high resistance type adjusted to read on the 150 volt scale.
- (iv) A 500 volt megger was used in the resistance tests and a minimum reading of 20 megohms was obtained.

56. Notwithstanding what I said in my statement, I asked for the proving circuits mentioned therein to be provided on signals D and K and on two other signals. I did this not because I believe that there may be some fault in the signalling equipment which has eluded our notice, but to make absolutely certain that there is none.

FURTHER EVIDENCE

57. Both Motorman Perry and Guard Walsh were present when I made the above statement, and I then re-examined them. I suggested to Motorman Perry that as signal D could not have been clear for his train he might have mistaken signal G for signal D and I explained that the former was in fact showing the aspect and indication which he thought he had seen on signal D. He was adamant however that signal D was showing green with the figure 14 in the route indicator. I suggested various ways to him in which he might have made a mistake, but nothing would shake him in his statement that signal D was clear.

58. Perry repeated that signal C was yellow and signal D was green when they first came into view; also that the reason for his feeling of uneasiness or surprise on seeing the latter at green was the glimpse he caught of the train ahead drawing into platform 4, 5 or 6. I showed Perry a scale plan which the Chief Civil Engineer had, at my request, prepared and I explained to him that when signal C came into view at a point some 170 yards from it (point X on the plan), and was seen to be at yellow, the rear end of the train ahead must have cleared track circuit DZ, the overlap track circuit beyond signal D; in other words it must have been at least 77 yards beyond signal D. After signal C had been sighted, the 6.12 p.m. electric train had to travel 530 yards to the point where signal D comes into view (point Y on plan, 130 yards from signal D). I showed him that, from the latter point, it is not possible, on account of the right handed curvature of the lines into the station and of a building on the inside of the curve (the Red Lion public house), to see the ends of any of the platforms with numbers lower than 11 and that, as the train proceeds towards signal D, the sighting of the tracks into those platforms becomes, if anything, still more obscured. I explained that while his train was travelling 530 yards from point X to point Y the train ahead of him had to travel a maximum of only 110 yards to be completely obscured from his view. In spite of all this factual evidence Perry insisted that he had seen the rear end of the train ahead outside No. 4, 5 or 6 platform and that, because of this, he was uneasy when he saw signal D at green and kept it in constant view.

59. Guard Walsh, on the other hand, was more or less prepared to admit that he might have made a mistake and misread signal G for signal D, but he was almost certain that he had not done so. He re-stated that having once seen a green aspect which he was confident was on his signal, he turned his eyes away.

CONCLUSIONS, REMARKS AND RECOMMENDATIONS

60. I am entirely satisfied that the Up Main Through inner home signal (signal D) was red when the 6.12 p.m. Up electric train passed it, and I have no alternative but to hold Motorman Perry responsible for this collision. From tests which I have made on the running times of trains into and out of Waterloo and having regard to the length of the approach locking track circuit on signal D and the point at which the collision occurred, I am equally certain that signal D could not have been clear when it first came into view from the electric train (point Y on the plan), and it must therefore have been red. In spite of his insistence to the contrary, I have no doubt that Perry saw the inner home signal on the Up Main Relief line (signal G), which was green and displayed a route indication to No. 14 platform for the 3.0 p.m. Bournemouth to Waterloo train, and assumed mistakenly that it applied to his train. It is significant that these were the precise indications that Perry asserted that he saw on signal D. It is difficult to suggest any reason for his failure. The most likely one seems to be that he thought momentarily that his train was on the adjacent Up Main Relief line, although he was certain that he had not done so.

61. It is obvious from his evidence that Perry still does not believe that signal D was red when his train passed it. He is a man with considerable self-assurance, and I think that he convinced himself immediately after the collision that he at any rate could not have passed a red signal. I think also that the more he considered the matter, the more convinced he became that this was the case. I think too that his story about keeping signal D in view until he had passed underneath it because he had seen a train ahead drawing into a platform on his right and was therefore uneasy, was a figment of the imagination created to convince himself that the signal on his line, signal D, was green. It is to be regretted that he rejected factual evidence that signal D could not have been green and that he could not have seen the train ahead, and that he was not prepared to admit that he may have made a mistake.

62. Perry is 40 years of age and he entered the railway service in 1937. He became a passed fireman in 1947 and was qualified as a motorman in 1948 and stationed at Selhurst. He was transferred to Wimbledon in 1954 and has worked trains into Waterloo regularly since then. His

sight and colour vision are normal and he told me that he was feeling well and that he had no worries of any kind on his mind. He had been working to the normal link duties and he said that he was not tired. His record is not entirely clear and includes a case of passing a ground signal at danger in January 1959; it also includes a commendation in 1957.

63. Guard Walsh could have prevented the accident if he had been keeping a proper lookout as required by the Rules. Approaching Waterloo however the observance of signals through a periscope is not easy on account of the curvature. He said that he had seen an inner home signal at green and had then turned his head away, but the signal which he saw must have been signal G on the Up Main Relief line which comes into his view before signal D.

64. I have mentioned that both the motorman and the guard of a train approaching Waterloo on the Up Main Through line can see the inner home signal on the Up Main Relief line shortly before they can see the inner home on their own line. I do not think that this had any direct bearing on the accident so far as Perry is concerned but I think that it did lead to the guard's failure to see his proper signal. As I have mentioned, the sighting of signals is difficult on account of the curvature of the lines, but I think that consideration should be given to the practicability of improving the sighting of these particular signals and any others where the same conditions obtain, by moving the signals slightly on the gantries or by altering their angle of focus, or even if necessary by altering to a small extent the position or height of a gantry. The use of lenses with a wide beam spread might also be considered.

65. In modern installations the approach locking track circuits extend sufficiently far to ensure that a signal, having once been seen by a driver at clear, cannot be replaced to danger to enable the route ahead of the train to be changed, but this is not the case on the Up lines at Waterloo. As I have said, I am certain that signal D was red when it came into view from the electric train and so this can have had no bearing whatever on this accident. Nevertheless, I consider that it would be advisable for the approach locking track circuits at Waterloo to be extended.

66. Although it had no connection with this accident, it was noticed that in certain conditions of bright sunlight the word "off" which is stencilled on frosted glass on both sides of the indicators on platforms can appear to be illuminated by the electric bulb provided for the purpose when in fact it is not, and that the viewing of an indicator with a bright artificial light behind it can produce the same result. This is undesirable, and I am informed that steps are to be taken to prevent natural or artificial light shining through the indicators.

67. In conclusion I would repeat that I consider the signalling equipment generally at Waterloo is in good order and is well maintained. I am completely satisfied regarding the integrity of the signalling which was tested, and I can see no reason whatever for any apprehension about the rest of the signalling or for any suspicion to be cast on it.

I have the honour to be,

Sir,

Your obedient Servant,

D. McMULLEN,

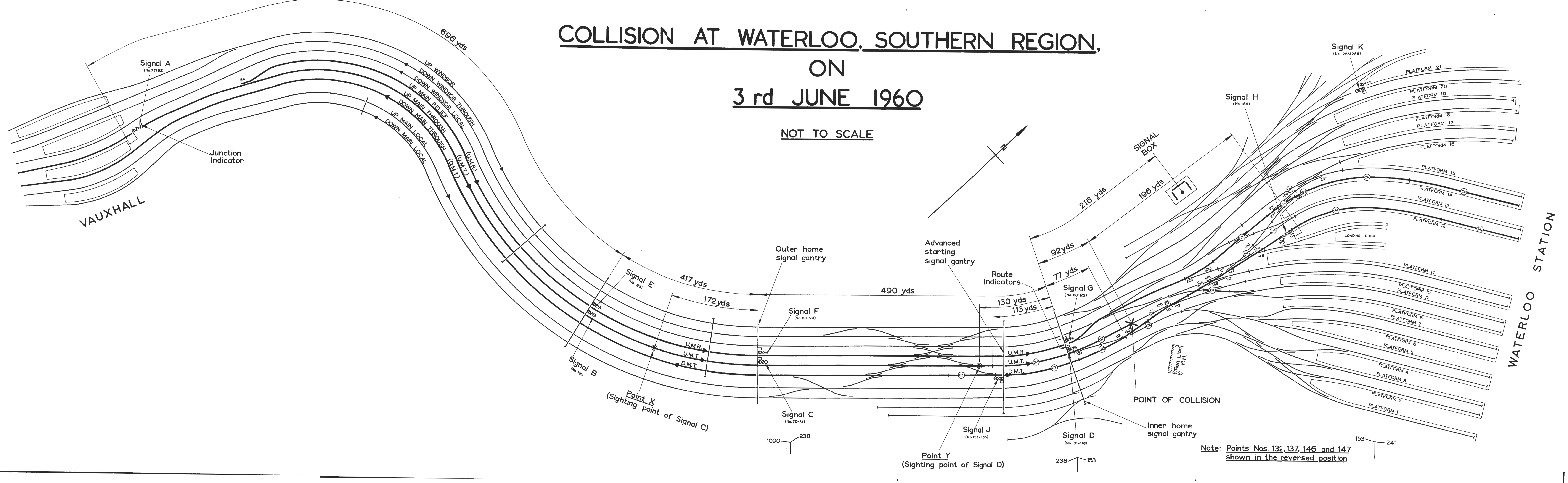
Colonel

The Secretary,

Ministry of Transport

COLLISION AT WATERLOO, SOUTHERN REGION, ON 3rd JUNE 1960

NOT TO SCALE



Note: Points Nos. 132, 137, 146 and 147 shown in the reversed position

TABLE I ELECTRICAL LEVER LOCKING (EXTRACT)

LEVER No.	RELEASED BY REVERSAL OF LEVERS	WHEN REVERSED LOCKS LEVERS
114	150 146 137 136	132 133 147 237
132		101 102 104 105 106 107 108 109 110 111 112 113 114 115 116
133		110 111 113 114 115 116 184
136		184 (137 (137))(146 (146 w 137))(147 (147) 148 (148 w 137) (146))(148 w (137) 146 228) (148 150 (150 w 137) (146) 147)(237 (237 w 137) (146) (150))
137		110 (108 109 w 133)
146		111 228
147	146	113 114 115 116 150
148		112 184 (136 w (137) (146) 147)(136 w (137) 146 228)
150		113 147 148 228
184	147 137 132	133 136 148 228
186	184	
228		146 150 184
237		114

TABLE II ELECTRICAL CONTROLS & DETECTION (EXTRACT)

DESCRIPTION	LEVER No.	RELEASED BY TRACK CIRCUITS CLEAR	DETECTS POINTS	APPROACH LOCKED BY TRACK CIRCUITS OCCUPIED	BACKLOCK RELEASED BY TRACK CIRCUITS
SIGNAL D TO No. 14 PLATFORM	114	DZ DX DY DF DG DH CK CJ BV CH (ADD CG FOR GREEN)	133 132 (137) (146) 147 228 (150) 237	DW	(DZ or (DX))
POINTS	132	DX EX			DX EX
POINTS	133	DZ GQ			DZ GQ
SHUNT SIGNAL	136	NIL	(137) (146) 147 228 (150) 237	DX (EX w (132))	
POINTS	137	DF DY			DF DY
POINTS	146	DF			DF
POINTS	147	DG DF			DG DF
POINTS	148	DN DG			DN DG
POINTS	150	CJ CK DH DG BV			CJ CK DH DG
SIGNAL H TO D.M.T.	184	DG DF DY DX EX GQ EY EZ	148 228 (147) (137) (146) (132) 133		DN DG (DF or (DY))
	186	DN DG		DL DM	DN
POINTS	228	CL DG			CL DG
POINTS	237	BW CJ BV			BW CJ BV

TABLE III ELECTRICAL ROUTE LOCKING (EXTRACT)

POINTS No.	BY TRACK CIRCUITS OCCUPIED	ROUTE LOCKED	
		WHEN POINTS	AND SIGNAL LEVER USED
132	DY	-	184
133	DY DX EX	-	184
137	DX	133	108 or 109 or 110 or 111 or 112 or 113 or 114 or 115 or 116
146	DX DY	-	111 or 113 or 114 or 115 or 116
147	DX DY	-	112 or 113
148	DX DY DF	-	112
150	DX DY DF	-	113 or 114 or 115 or 116
237	DX DY DF DG DH	-	114 or 115 or 116

NOTES

1. Levers Nos. 101-116 are the levers which control Signal D.
2. Unencircled figures, Table I Col 3, indicate that the lever is normal and, in Tables II & III, that the points are normal.
3. Encircled figures, Table I Col 3, indicate that the lever is reversed and, in Table II, that the points are reversed.
4. Unencircled letters, Table II Col 6, indicate that the track circuit must be occupied and then cleared: encircled letters indicate that the track circuit must be occupied.
5. w means when.
6. Example:- Table I- Lever No. 136, when reversed, locks lever No. 184 normal, No. 137 normal or reversed, No. 146 normal or reversed when No. 137 is reversed, etc.