L.N.E.R.

CHIEF ENGINEER'S DEPARTMENT

TECHNICAL INSTRUCTIONS

(SIGNALLING AND COMMUNICATIONS)

MAIN INDEX

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Signalling Principles.
Provision of Track Circuits at Stop Signals on Passenger Lines.

GENERAL

1. The purpose of this instruction is to define the conditions under which track circuits should be provided at Stop Signals on passenger lines and to what extent.

2. Where more than one track circuit is provided on a running line, in interlocking areas, the guiding principle must be that the position of a train should be indicated either on the Block Instruments or on the Signal Box Diagram. It is therefore desirable, in such circumstances, that there should be continuous Track Circuiting in the Area controlled from the Signal Box concerned.

3. When new works or modernisation and betterments are being considered, Track Circuiting should be made continuous, where provided on the running lines, within interlocking limits.

4. All installations of Track Circuiting must be the subject of agreement with the Superintendent.

TRACK CIRCUIT PROVISION

5. Track Circuits should be provided at the following signals :—

(*a*) Stop Signals out of sight of the signalman.

(*b*) Stop Signals situated more than 400 yards from the Signal Box.

(*c*) Home or Home No. 1 Signals more than 200 yards from the Signal Box.

(*d*) Inner and Outer Home Signals.

6. In all cases, Track Circuits should normally terminate at the second rail joint in advance of a signal.

7. A Track Circuit which is being provided at a Signal should be made contiguous with an existing or a new Track Circuit in rear in all cases.

8. A Track Circuit at a signal should normally extend back to the next signal in rear. If, however, there is no track circuit at the rear signal and the portion of line between the latter signal and the first point connection ahead of it is readily visible from the Signal Box, the Track Circuit need only extend from a point immediately ahead of this connection.

9. In case 5(*c*), the Track Circuit should normally be 200 yards in length.

10. In case 5(*d*), the Track Circuit should normally commence 200 yards on the approach side of the Outer Home Signal and terminate at the Inner Home Signal or, where such a signal is not provided, 440 yards ahead of the Outer Home Signal. In certain cases, for example where the Inner Home Signal is out of sight of the signalman, the Track Circuiting should be divided at the Outer Home Signal.

11. Any proposals for additional track circuit, other than those indicated herein, will be considered on their merits.

EXCEPTION

12. An exception to the above instruction may be made for isolated stretches of single line, where there is no existing electrical signalling and where the Lineman is stationed a long distance away (e.g. some portions of the West Highland Line). In these circumstances Track Circuits should not be provided unless special authority has been obtained.

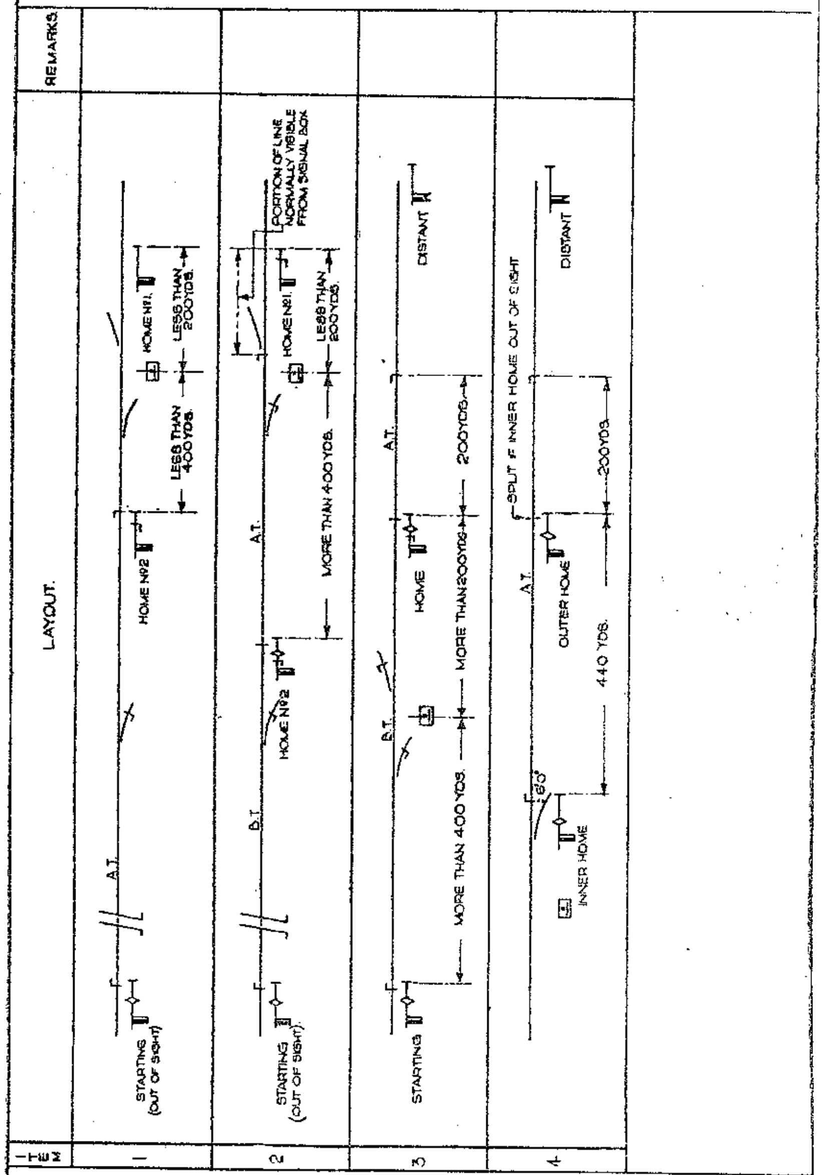
APPENDIX

13. In the diagram forming the Appendix, there are four items illustrating typical examples of the provision of Track Circuits as follows :—

Item 1 illustrates case 5(*a*) under condition 7 (first part).
Item 2 illustrates cases 5(*a*) and 5(*b*) under conditions 6 and 7.
Item 3 illustrates cases 5(*b*) and 5(*c*) under conditions 7 and 8.
Item 4 illustrates cases 5(*d*) under conditions 8 and 9.

Reference: *A.C.E.(S) Conference Minute No.* 49/45.
Authorised by Chief Engineer. 8.3.45.

APPENDIX.



STOP SIGNALS.

TYPICAL LAYOUTS SHOWING

PROVISION OF TRACK CIRCUITS

L.N.E.R. A.1004.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

SIGNALLING—GENERAL,
Signalling Principles.
Control of Intermediate Siding.

GENERAL

1. The control of intermediate Ground Frames working sidings, as described in this Instruction, is designed to satisfy the following requirements:—

(a) To give full protection to a train working at the siding.

(b) To prevent unauthorised operation of the ground frame.

(c) To ensure that the ground frame is restored to normal before the passage of a following train.

2. In all new installations, ground frames working intermediate sidings must be controlled by the appropriate methods, described in this instruction, according to the conditions obtaining at the particular localities.

3. It is desirable that all ground frames should have a telephone provided to the controlling signal box or to the nearest open box in the rear.

TRACK CIRCUIT CONTROL

4. In sections where there is continuous track circuiting the ground frame must be controlled by one track circuit with time-element relay, locking the point lever electrically and releasing this lever when the track circuit concerned has been occupied a pre-determined time. (See Appendix, Item 1). This ensures compliance with (*a*) and(*b*).

5. To enforce compliance with (*c*), the reversal of the point lever must maintain the track circuit in the " occupied " condition.

6. In such cases a separate release lever is not necessary but an Indicator must be provided to show when the lever is " Locked " or " Free."

7. The length of the track circuit concerned and the time of occupancy before release of the point lever will be decided, in agreement with the Superintendent, according to the factors involved at each location.

ELECTRICAL CONTROL

8. In cases where the signal box in the rear is open at all times when the siding is required to be used and track circuiting does not exist throughout, the ground frame may be controlled from the signal box in the rear by the standard electric control. (See Appendix, Item 2).

9. The ground frame points are then effectively interlocked with the starting signal and that signal must be released by " Line Clear " (one movement only) to meet requirements (*b*) and (*c*).

CONTROL BY ANNETTS LOCK ON STARTING SIGNAL

10. If the rear box is always open when the siding is to be used, the ground frame may be provided with an Annett's Lock the key for which, when withdrawn from a similar Lock on the starting signal lever, prevents that lever being pulled until the Annett's key is returned. This method of control ensures compliance with (*b*) and (*c*) but is limited in its application to situations where traffic conditions permit the key to be returned from the box in advance before the starting signal requires to be pulled again.

CONTROL BY PADLOCK

11. If the rear box is not always open when the siding is to be used or the traffic conditions are such that the Annett's key method is undesirable, the ground frame may be padlocked to comply with (*b*). The key or keys may be kept at a convenient place in rear of the siding and handed in after operation of the ground frame at a convenient place in advance for subsequent return. The padlock may take the form of an Annett's Lock if so desired.

12. In this method, there is no effective interlocking between the ground frame points and the starting signal and hence to satisfy requirement (*c*) it is necessary to provide Home and Distant signals worked from the ground frame or, alternatively, slots on the rear box signals if reasonably close. In view of the additional signals required, this method should be avoided wherever possible.

ADDITIONAL PROTECTION BY BLOCK CONTROL

13. Full protection (requirement (*a*)) is only given to a train working the siding if the acceptance of a second train by the forward box is prevented until the first has cleared the section.

14. This protection is inherent in cases where the track circuiting is continuous between the signal boxes which are open at the time the ground frame is in use and also in cases where the ground frame is protected by automatic signals.

15. In cases where the ground frame is controlled by Annett's lock on the starting signal no further protection is necessary since even if a second train were accepted on the block the starting signal cannot be pulled.

16. It is however, necessary to provide additional protection in cases where the ground frame is controlled electrically or by padlock. This protection must be given by releasing the rear box starting signal by " Line Clear " (one movement only) and providing the " Welwyn " type of block control at the accepting box, extending these controls to boxes in rear and in advance as necessary to cover switching out.

17. Where the cost of extending these controls is uneconomic the Superintendent should be approached to see whether, in view of the cost it can be arranged for the ground frame to be worked only when the boxes immediately on either side of it are open.

Reference: A.C.E. (S) Conference Minute No. 108/45.

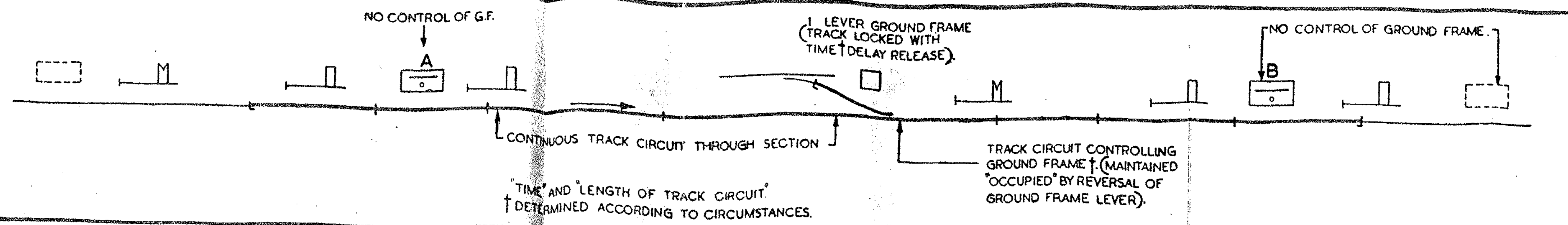
Authorised by Chief Engineer. 30.11.45.

CONTROL OF INTERMEDIATE GROUND FRAMES.

VARIOUS METHODS APPLIED TO A TYPICAL LAYOUT.

ITEM		REMARKS.
1	See diagram 1	TRACK CIRCUIT CONTROL.
2	See diagram 2	ELECTRICAL CONTROL.
3	See diagram 3	CONTROL BY ANNETTS LOCK ON STARTING SIGNAL.
4	See diagram 4	CONTROL BY PADLOCK.

1



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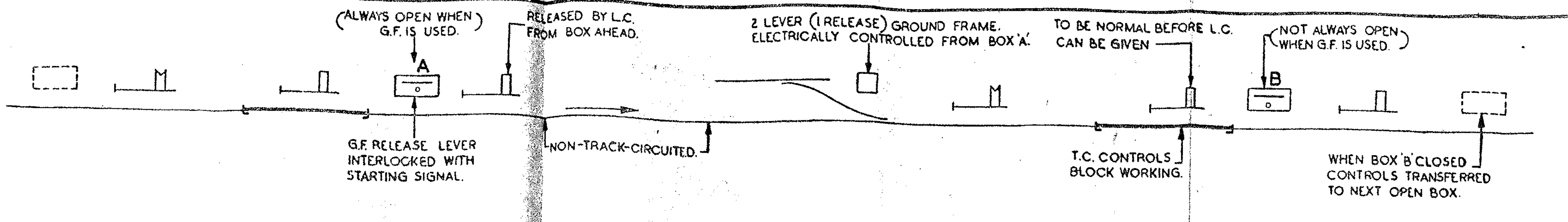

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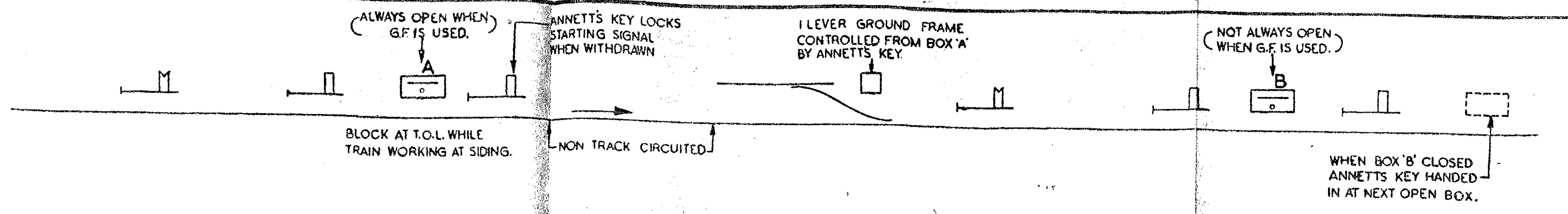

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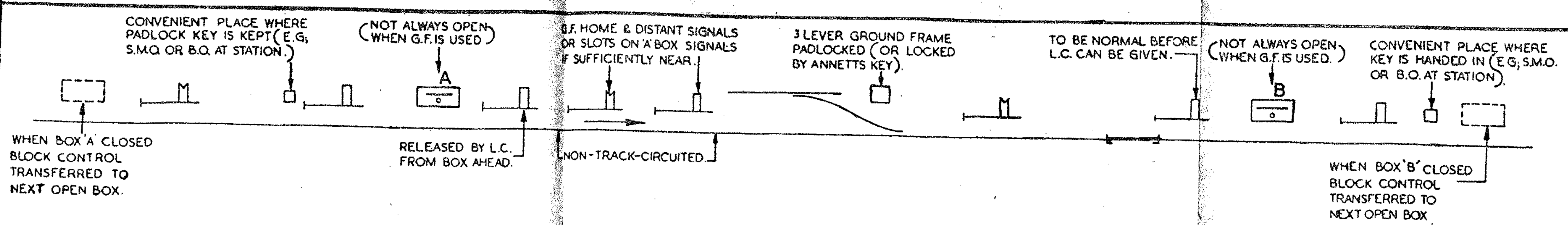

APPENDIX

L.N.E.R.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

A.1602

SIGNALLING—
GENERAL.
Painting.
Point Rodding.

GENERAL

1. This Instruction states when and how point rodding is to be painted and the type of paint to be used for maintaining the rodding in good condition.

GALVANISED RODDING

2. When the protective coating of galvanising begins to show signs of weathering and before corrosion starts, the rodding to be wire brushed and given one coat of red lead and boiled linseed oil paint and one coat of oxide and graphite paint, and thereafter at intervals of not more than five years.

PAINTED RODDING

3. Where rodding exists which is already painted, it should be treated as soon as signs of corrosion appear and in any case at intervals of not more than five years, as described in the following paragraph.

4. The rodding to be wire brushed and given one coat of red lead and boiled linseed oil paint and one coat of oxide and graphite paint.

TARRED RODDING

5. Where rodding exists which is already tarred, it should be treated as soon as signs of corrosion appear and in any case at intervals of not more than three years, as described in the following paragraph.

6. The rodding to be wire brushed and given one coat of tar paint; being a solution of one gallon of coal tar (thin) mixed hot with 3 ozs. of lime and 3 ozs. of Russian tallow.

SIDE FRAMES AND ROLLER STOOLS

7. Side Frames and metal roller stools, where installed, should be given the same treatment at the same time as the respective types of rodding.

ROLLERS

8. Point Rod Rollers are not to be painted or tarred in any circumstances.

Reference: A.C.E. (S) Conference Minute No. 80/44.
Authorised by Chief Engineer: 29-3-44.

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Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

SIGNALLING—MECHANICAL.

Signal Structures.

Clearances, Material, Type and Size.

GENERAL

1. This Instruction sets out the requirements with regard to Signal Structures relating to the material of which they can be made, the shape or type of structure desirable and the sizes which should generally be used in different circumstances.

CLEARANCES

2. Signal Structures as a general rule should be at a distance of 6 ft. 0 in. from outside rail. No structure may be nearer than 4 ft. 9 in. from rail nor fittings thereon nearer than 4 ft. 3 in., if at a height of less than 12 ft. 0 in. from rail level, without special authorisation. Appendix A shows clearances for typical structures.

MATERIALS

3. Signal Structures may be made of the following materials :—

(*a*) Steel.

(*b*) Wood.

(*c*) Concrete.

The structures may take the form of :—

(*d*) Tubular Steel Posts.

(*e*) Fabricated and Welded Structures.

(*f*) Square Section wood or concrete posts.

TYPE AND SIZE.

4. The type of Structure will be decided by the circumstances for which the signal is to be used, and may take the form of :—

(*a*) Straight post 27 ft. 6 in. and under.
(*b*) Straight post over 27 ft. 6 in.
(*c*) Bracket.
(*d*) Overhead Gantry.

5. When signals are 27 ft. 6 in. or below, tubular type posts should be used. Posts for both semaphore and mechanical colour-light signals are as shown in Appendix B, except :—

(*a*) In specially authorised cases, other profiles may be necessary and wood or concrete posts may be used for straight posts of whatever height, or wood may be used for bracket signals, in like circumstances.

(*b*) For a colour-light signal in an isolated location, a concrete post is standard, as shown in Appendix C, and should be used.

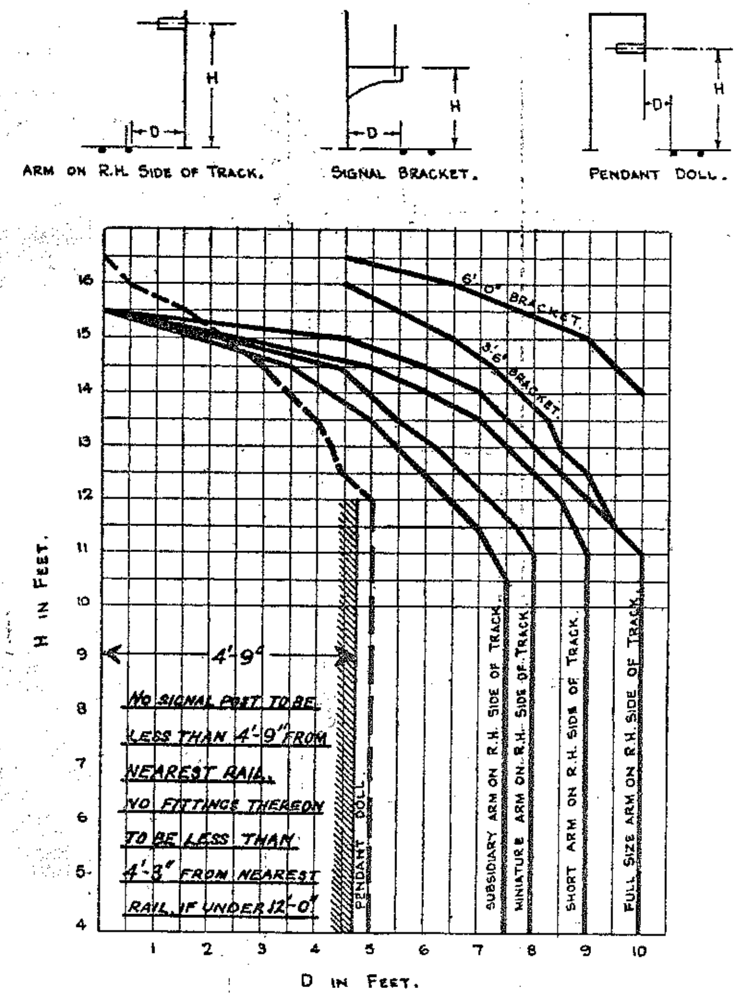
6. For signals above 27 ft. 6 in. in height, batten type welded steel signal posts, with tubular dolls will have to be used, as shown in Appendix D.

7. When bracket signals are necessary, they should be limited, except in special cases, to the various types shown in Appendix E.

8. All gantries or cantilever brackets for either semaphore or colour-light signals are to be of welded steel construction and will generally be designed individually as occasion demands.

Reference: A.C.E. (S) Conference Minute No. 122/44.
Authorised by Chief Engineer. 7.4.44.

APPENDIX A.

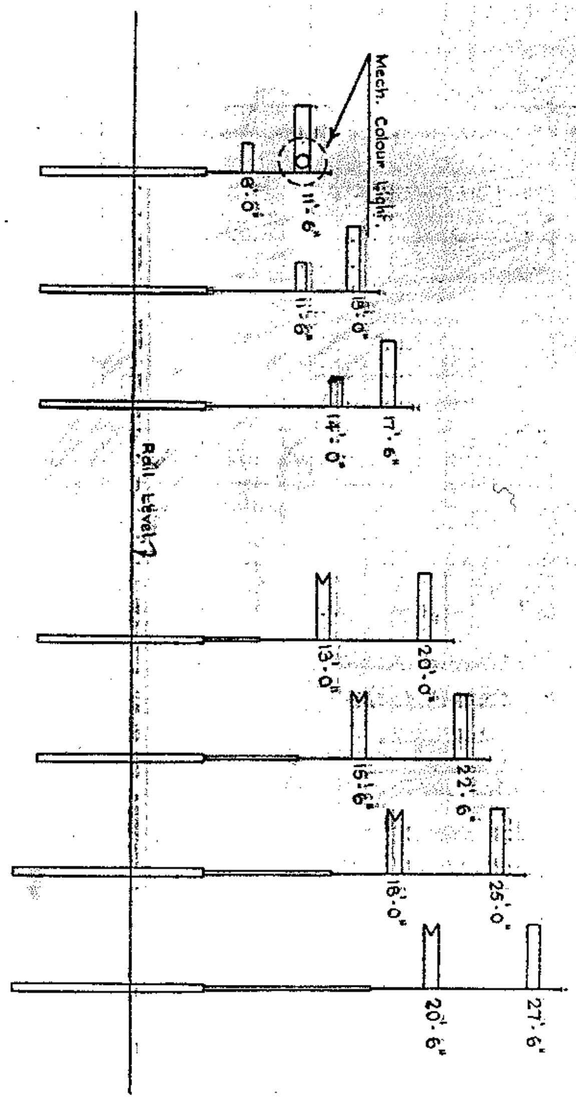


Notes:-
1. Height "H" refers to distance from Rail Level to CENTRE of Signal Arm or TOP of Bracket Landing.
2. Distance "D" refers to distance from OUTSIDE edge of nearest rail to CENTRE of Signal Post.
3. Distances shown refer to STRAIGHT Track and allowance must be made for super-elevation in cases where Signals are sited adjacent to Curved Tracks.

STANDARD U.Q. MECHANICAL SIGNALS.

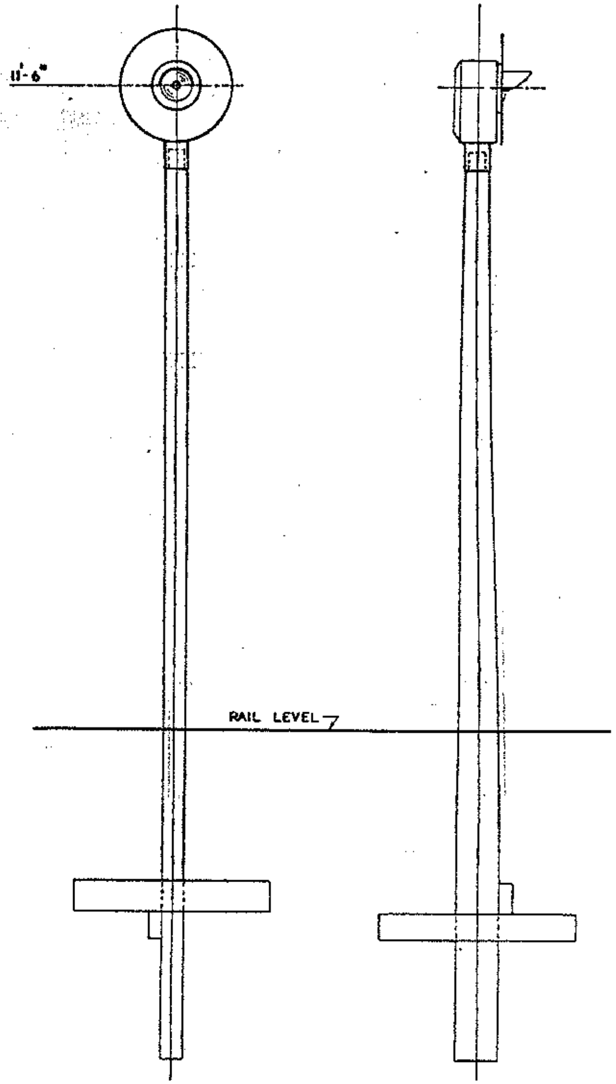
ABSOLUTE MINIMUM CLEARANCE FROM STRUCTURE GAUGE.

APPENDIX B



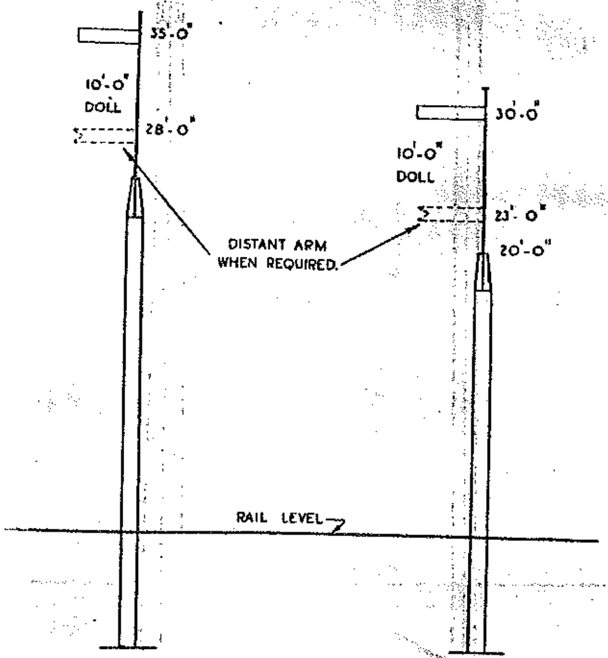
TUBULAR STRAIGHT POSTS UNDER 30'-0."

APPENDIX C



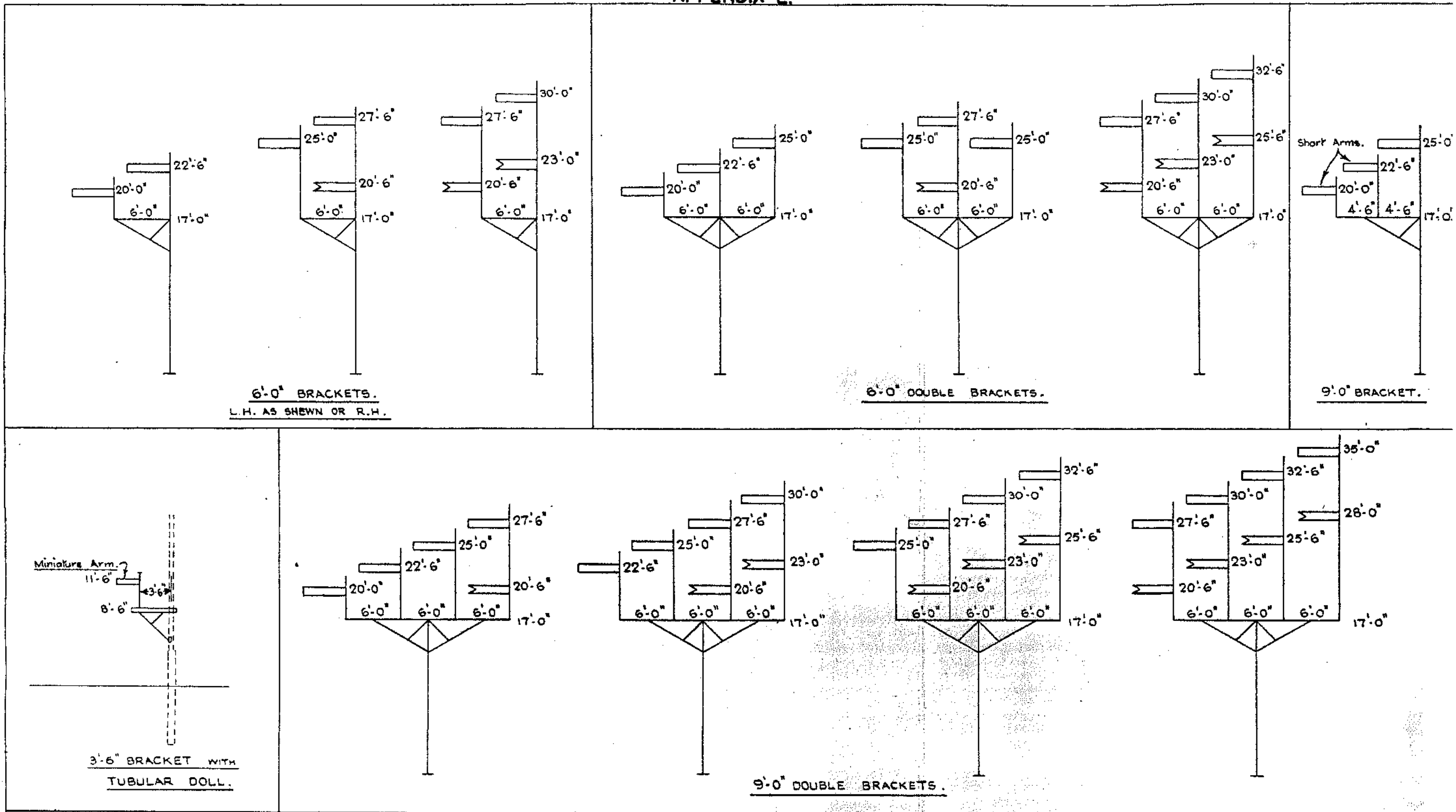
STANDARD CONCRETE POST
FOR
COLOUR LIGHT DISTANT SIGNAL.

APPENDIX D.



STRAIGHT POSTS 30'-0" & OVER.

APPENDIX E.



STANDARD BRACKET SIGNALS.

DIAGRAM OF TYPICAL ARRANGEMENTS OF ARMS & DOLLS.

THESE SIGNALS ARE CONSTRUCTED WITH BATTEN TYPE MAIN POSTS.
AND BRACKETS WITH TUBULAR DOLLS.

L.N.E.R.

Chief Engineer's Dept.

Technical Instructions.

Signalling and Communications.

B. 1102.

Signalling—Mechanical

Timber Signal Posts.

Marking, Inspection and Testing.

GENERAL

1. Large numbers of timber signal posts are in use, which are likely to remain for many years until eventually replaced by steel posts.

It is important, therefore, that these timber posts should be regularly inspected and tested to ensure their timely replacement, if defective.

2. To facilitate description and identification of such posts, it is necessary that they should all bear reference numbers.

3. In order that the foregoing may become effective, the following instructions are to be carried out.

MARKING

4. All signal posts are to bear the appropriate lever number and the year of planting of the timber post (where this is known).

5. The lever number should be of 3 in. metal letters screwed to the post on the same side as the signal arm/s and immediately beneath should be the last two digits of the year of planting made up by number nails, *e.g.*

15

④ ⑤

6. The height to the base of the lever number should be ten feet from the Butt.

INSPECTION AND TESTING

7. All timber signal and stay posts must be inspected annually. After having been planted for ten years, they must be exposed and probed to a depth of two feet below ground level and, thereafter, they must be examined in this manner at three-yearly intervals.

8. All posts showing evidence of decay, at any time, must be exposed and probed as above.

9. Inspections must be carried out by an Inspector or other equally responsible member of the staff, and proper records kept so that, in any one year, it will be known which posts have to be exposed and probed on the three-yearly basis.

10. Any evidence of decay must be reported to the Area Office (quoting the reference for the signal) and, where necessary, immediate action taken to effect temporary repairs. Permanent renewal will be proposed as heretofore in the Annual Signal Renewal Programme.

Reference: A.C.E. (Signals) Conference Minute No. 97/45.

Authorised by Chief Engineer: 4.9.45.

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L.N.E.R. **B. 1103**

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

SIGNALLING—MECHANICAL

Signal Posts.
Marking for Proposed Renewal.

GENERAL

1. In order to draw attention readily to signal posts requiring renewal, all such posts must be marked in accordance with the following instructions.

PROPOSED RENEWAL

2. All posts proposed for renewal must be marked before inspection by painting two vertical 1 inch white stripes about 6 inches long and parallel to each other at a distance of about 3 inches apart.

3. The stripes to be placed at a height of about four feet above ground level, or as fittings permit, on the side of the post facing the Track.

RENEWAL AGREED

4. After inspection, if the renewal of the post is agreed, the white stripes must be painted over with red so as to obliterate the white.

5. The red paint should be of a distinctive light shade so that it will be easily distinguished from the background colour (*e.g.*, vermillion).

RENEWAL NOT AGREED

6. If the renewal is not agreed the white stripes should be left on the post in readiness for the following year's proposals. If necessary a re-touching of white paint should be applied immediately before further inspections.

Reference A.C.E. (S) Conference Minute No. 13/46.
Authorised by Chief Engineer 10-4-46.

LNER 5264/7/46 250

L.N.E.R.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

B.1209.

SIGNALLING—MECHANICAL.

Signal Connections.
Use of Split Links.

1. Split links are only to be used for temporary emergency repairs or in exceptional circumstances where specially authorised.

2. Split links must never be used for running line signal connections working through detectors or in signal guy wires, even for emergency repairs.

3. On permanent installation works, ordinary split links are unnecessary and only tend to cause subsequent failures by opening out under strain.

4. Apparatus must be connected by making a wire joint, as described in another instruction, round a thimble placed in the chain, shackle or wire regulating screw.

5. In cases where the use of split links is permitted, they must be of the " Duplex " pattern only.

Reference A.C.E. (S) Conference Minute No. 31/46.

Authorised by Chief Engineer. 26.6.46

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L.N.E.R. **B.1210**

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

SIGNALLING—MECHANICAL.
Signal Connections.
Use of Wire Cranks.

GENERAL

1. This instruction states how wire cranks may be used to obtain the best results from them and why they are preferable to wheels in the wire run, within certain limits.

2. In a signal wire run, where right-angle or near right-angle turns are necessary, cranks should be used where possible, instead of wheels, because :—

(*a*) There is less friction with cranks than with wheels.

(*b*) The crank arms may be set, if required, to allow the wire to clear rails or adjacent fittings.

(*c*) A crank forms an integral link in the run and is less liable to seize or bind than a wheel and chain.

STROKE

3. To avoid hard working or choking, crank arms must always be arranged so as to work within the limits of 30° either side of the mid-stroke position. This allows a maximum stroke of 12 inches.

WIRE ADJUSTMENT

4. Where wire adjustment is provided on one side of the crank, it is necessary to ensure that such adjustment shall not cause the crank arms to work outside the limit laid down in the preceding paragraph.

RESTRICTED USE

5. Because of the above factors, the use of wire cranks is restricted to a maximum length of wire of 300 yards from the signal. They should be used from this distance to the signal but if the signal is farther than 300 yards from the signal box, then wheels must be used for the first part of the wire run that is in excess of this distance.

6. Where a wire adjuster is provided in the signal box, the maximum distance given above must be reduced to 200 yards so that sufficient allowance may be made for the movement of the crank arms during wire adjustment.

7. The above distances are calculated on the assumption that the slack in the wire run does not exceed a value of 1 inch per 100 yards and that the stroke required at the signal is 8½ inches. Due allowance must be made for any departure from these figures.

CRANKS ON SIGNAL POSTS

8. Standard positions for wire cranks at the foot of tubular signal posts are shown in the Appendix. The examples shown are all at 1′ 6″ above rail level, except where the wire passes under the track (v. example No. 3) when the crank is fixed in the lower position at 1½ inches above rail level, or where wires run to a signal in opposite directions (v. example No. 4) when one crank has to be fixed in the lower position.

9. In all cases the wire crank will correspond with the standard positions of Balance Lever Plates. The positions apply equally to welded batten type steel posts, for signals over 27′ 6″ in height.

APPENDIX

10. The examples illustrated in the Appendix are as follows :—

1. Single wire crank with 9 inch extension plate. This is to be used for signals, without a balance lever, where the wire run is to the back of the post and on the same side of the track.
2. Single wire crank, with 18 inch extension plate. This is to be used for signals, with a balance lever, where the wire run is to the front of the post and on the same side of the track.

   Where a balance lever is not required, the hole at 15 inches in the extension plate should be used instead of the hole at 18 inches as shown.
3. Single wire crank with 18 inch extension plate. This is to be used for signals, with or without a balance lever ; where the wire run passes under the track to the crank.
4. Single wire cranks, one with an ordinary plate and the other with an 18 inch extension plate. These to be used for signals with dual control ; the wires being on the same side of the track as the signal, but run from opposite directions.

11. Any other combination of cranks and fixing may be worked out from the above examples, according to different conditions obtaining in individual circumstances.

Reference : A.C.E. (S) Conference Minute No. 70/43.

Authorised by Chief Engineer. 18.11.43.

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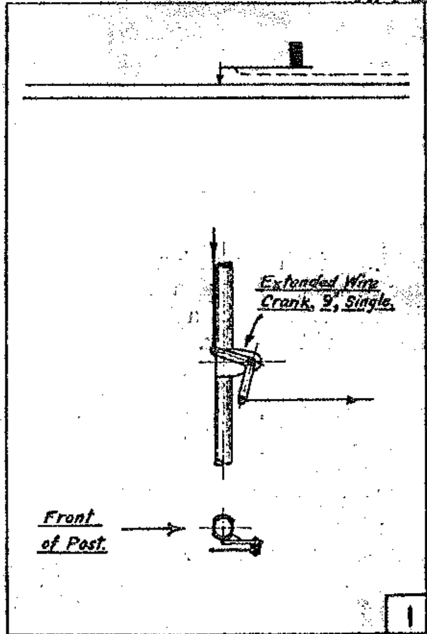
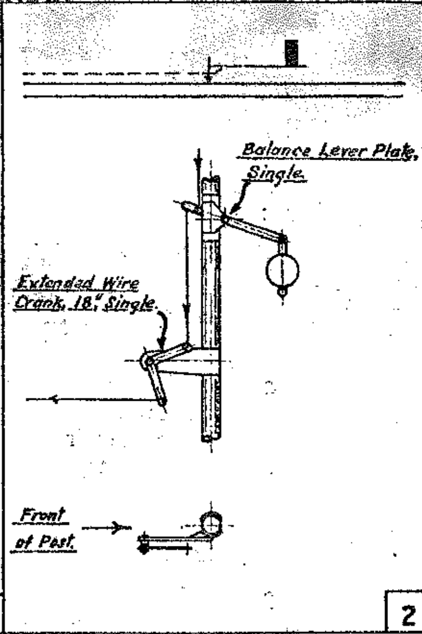
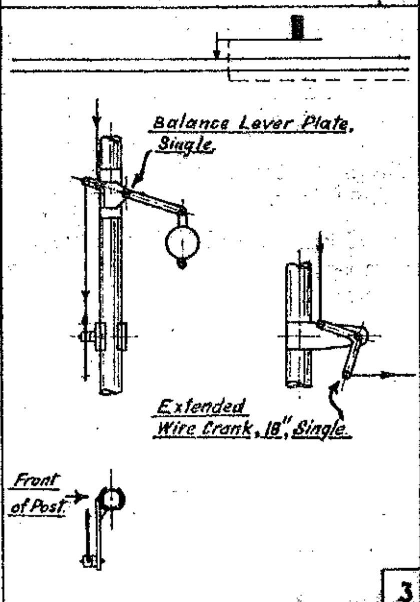
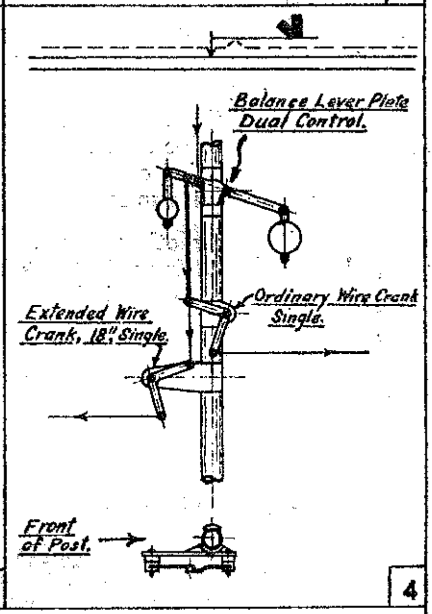








WIRE CRANKS.

TYPICAL ARRANGEMENTS OF FIXING AT BASE OF TUBULAR POST SIGNALS

GENERAL

1. Joints should only be made in galvanised (standard 7/17 S.W.G.) signal wire or the various standard sizes of stay wires where absolutely necessary.

For example, joints will be required :—

(*a*) To connect wires to chains and shackles of apparatus.

(*b*) To join two coil lengths of wires together on long runs.

(*c*) To join breakages in case of emergency.

2. This instruction states what methods must be employed for the different types of joints for all cases other than those specifically allowed in an emergency as mentioned in instruction No. B.1209.

3. The use of pliers or other tools for making any joint must be avoided, except for cutting the strands.

TERMINAL JOINTS

4. Terminal joints are to be used to connect wires to apparatus and must be made as follows :—

5. The joint must be made round a thimble, which has been placed in the chain link, shackle, wire regulating screw or eye joint of stay tightener that is being connected.

6. The loose end of the wire must be left sufficiently long to enable it to be bent by hand and neatly formed into a loop over the thimble. The loop should be formed so as not to open the strands of wire.

7. The thimble must be firmly gripped when the two parts of the wire are placed together. This is best accomplished by giving the wire a slight backward set before forming the loop and then the loose end is also given a slight set so that it will lie snugly along the slope of the thimble and parallel to the other part of the wire.

8. One strand from the free end of the wire is chosen so that it comes from inside the loop and from under the thimble. It is then taken round one of the two parts of the wire for one half-turn and then bound round both parts, commencing close up to the neck of the loop. This strand is tightly bound round both parts of the wire for seven turns and then terminated.

9. Each remaining strand of the loose end must then be taken in turn and bound tightly round the remainder of the two parts of the wire similarly to the first strand, until all the strands have been used. For signal wire, the number of strands will be seven but the number may vary for stay wire.

10. The finished joint should have a neat appearance as shown in Appendix A.

RUNNING LINE JOINTS

11. Joints in the wire run should always be made towards the middle of a span and never so close to wire stakes that there is any possibility of the joint fouling the pulleys.

12. No two joints should come opposite each other in a wire run and joints in adjacent wires should be staggered to prevent any possibility of one fouling another when a wire is pulled.

13. Running Line Joints should be made by laying the two ends of wire alongside and parallel to each other for a sufficient distance to allow for the length of the joint and leaving enough length over to enable the strands of wire to be bent by hand.

14. A strand is taken from one loose end and commencing at the centre of the lap is tightly bound round the other wire and the remaining strands, in a direction so as to close the lay of the strands, for seven turns and then terminated.

15. The succeeding strands are then bound closely and tightly round in the manner described for terminal joints. When one end is completed the other is commenced and dealt with in the same way, starting with a strand as near the centre as possible.

16. Alternatively, if there is tension in the wires being joined, after binding in the first strand on one side, the first strand on the other side may next be taken, so as to keep the two ends from slipping while the remaining strands are dealt with. These may be taken in whatever order appears preferable.

17. In either case the finished appearance of the joint should be neat and in general as shown in Appendix B.

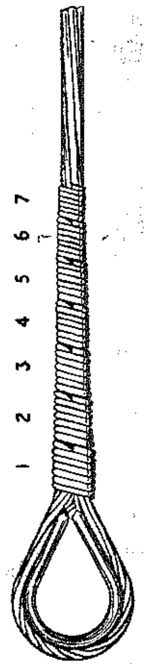
18. Another way of making this joint is by binding a few turns of single strand wire temporarily round each loose end, sufficiently far back to allow of manipulating the strands in making off. Then the strands are opened fan-wise, except for the two centre strands which are left straight. The two ends are then brought together so that the two centre strands are parallel with each other; the temporary bindings as close together as possible and the radiating strands interweaving one side with the other. Then starting with the two parallel strands, a joint is made as already described. The finished joint will closely resemble that shown in Appendix B.

It is considered that this method gives slightly more tensile strength than the other, but it may be left to individual preference and local circumstances to determine which method is to be employed.

Reference A.C.E. (S) Conference Minute No. 31/46.

Authorised by Chief Engineer. 26.6.46

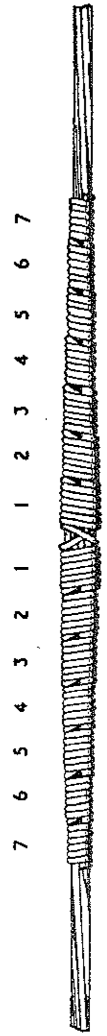
APPENDIX A.



TERMINAL JOINT.

MAKE-OFF TO THIMBLE.

APPENDIX B.



RUNNING LINE JOINT.

L.N.E.R.

Chief Engineer's Dept.
Technical Signalling and Communications Instructions.

C.1002.

SIGNALLING—ELECTRICAL.
D.C. Track Circuits.
Track Feed Sets.
Copper-Oxide Rectifier with Primary Cell.

GENERAL

1. In cases where a power supply is provided, a D.C. Track Circuit should be fed from a Rectifier/Primary Cell Standby type Track Feed set, the circuit for which is shown in Appendix A.

2. The track circuit is normally fed from the rectifier through a feed resistance, but on failure of power supply, the power-off relay releases and connects the primary cell to the track circuit through a separate feed resistance.

RECTIFIER

3. The Rectifier referred to in this instruction is a full wave copper-oxide type, fed from a variable—re-active transformer having secondary taps for output voltage adjustment.

4. These taps are designed to enable the full output to be obtained when the supply voltage is within the limits of 200/250 volts or 100/120 volts.

5. The transformer is provided with an adjustable magnetic shunt or leakage block to give a finer adjustment than is obtained by the transformer taps.

6. The Rectifier is rated at a maximum D.C. output of 1 amp. at either 1.4 or 2.5 volts, and is known as the Style RTO Rectifier and may be obtained for nominal input voltages of 230 or 110.

7. The reverse resistance of the rectifier is too high to drain the primary cell or affect the track circuit. The rectifier is not therefore disconnected on power failure, thus avoiding an unnecessary disconnection when the power supply is restored.

PRIMARY CELL

8. The standby primary cell generally used with this feed set is known as the AD.238.N. type. This is a caustic-soda air-depolarising cell having a capacity of 150 AH. (Zinc Life).

9. The initial voltage of the AD.238.N. cell is of the order of 1.3 volts. The cell should be renewed when the voltage on load drops to 0.95, but as the cell is only in use during periods of power failure, it may reasonably be expected to have a life of several years.

POWER-OFF RELAY

10. The Power-Off Relay usually consists of a double-wound telephone type relay each winding of which is connected in series with a half-wave rectifier so that the relay is maintained during each half cycle by one winding.

11. The internal wiring of this type of Power-Off Relay is shown in Appendix B.

ADJUSTMENT

12. The contact pressure on the de-energised contact is low and it is, therefore, important to observe that the voltage drop across it when the primary cell is in use is not greater than 0.1 volt.

13. The adjustment should be made in accordance with Technical Instruction No. C.1021.

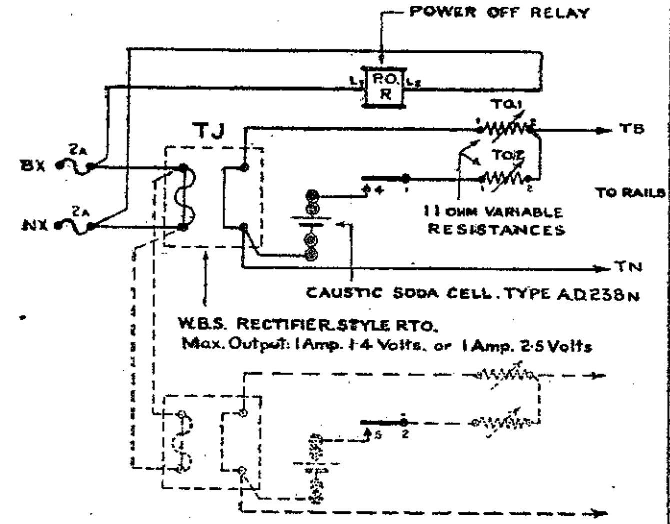
14. The track circuit should be set up with the Rectifier supplying the energy, after which the power supply should be disconnected by withdrawing a fuse and the track circuit set up with the primary cell supplying the energy.

15. Particular attention should be given to obtaining the correct output voltage (on load) required for stable adjustment. It should be noted that the rated voltage of the rectifier is at maximum output current of 1 amp. The track circuit feed end current will be considerably less than 1 amp and the rectifier voltage will therefore be higher than the rated value.

Reference: A.C.E. (S) Conference Minute No. 54/43.
Authorised by Chief Engineer. 18.11.43.

LNER 1513/2/46 250

APPENDIX A.



Where two Track Feed Sets are housed in the same Location a common Power Off Relay to be used. Wiring of second feed shown dotted.

WIRING OF TRACK FEED SETS.

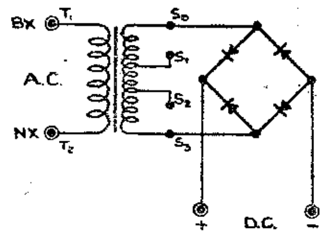


DIAGRAM SHOWING INTERNAL WIRING OF RECTIFIER UNIT

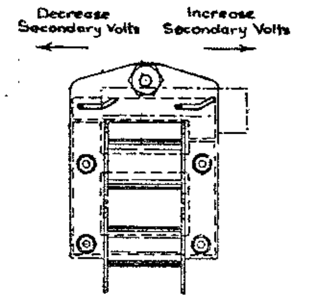


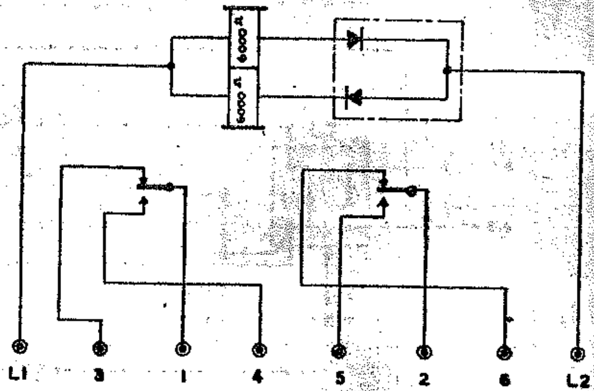
DIAGRAM SHOWING LEAKAGE BLOCK ADJUSTMENT (where this is fitted)

D.C. TRACK CIRCUITS.

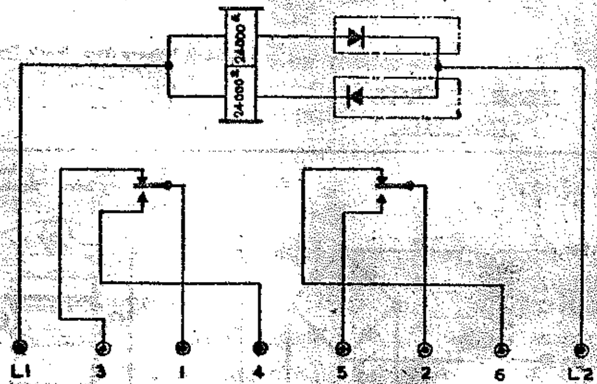
FEED SETS.

RECTIFIER / PRIMARY CELL STANDBY TYPE

APPENDIX B.



110v TYPE.



230v TYPE.

"POWER OFF" RELAYS.
INTERNAL WIRING.

L.N.E.R.
Chief Engineer's Department
Technical Instructions
Signalling and Communications

C. 1031
Electrical Signalling
D.C. Track Circuits
Standard method of adjustment where fitted with Primary-Secondary Relay Combination.

GENERAL

1. The minimum ballast resistance of track circuits may in certain situations fall below 2 ohms. If a 10 ohm relay were used in these cases and adjusted to give pick-up volts at a minimum ballast resistance of say 1 ohm, it would be found that the drop-away shunt, at one end or other of the track circuit, would be less than 0.5 ohm when the ballast had dried out to a comparatively high figure (say about 5 ohms.)

2. The limits of ballast resistance between which the track circuit would work safely would thus be seriously reduced. It is therefore necessary to use a more suitable arrangement.

3. A reduction of the relay resistance will affect an improvement in the working range of the track circuit. Greater improvement can be effected by the use of the Primary—Secondary Relay combination, owing to its other advantages which are detailed later.

DESCRIPTION OF THE PRIMARY-SECONDARY RELAY COMBINATION.

4. Modern D.C. Track Relays are designed so that the ratio of drop-away volts to pick-up volts is about 70 per cent. This difference is due to the air gap in the magnetic circuit necessitating a greater flux to pick up the relay than is required to hold it up.

5. It will be clear that if the pick-up and drop-away values can be brought closer together, more efficient shunting would be obtained.

6. One method of increasing the shunting sensitivity of the relay is to insert a resistance in series with the Track Relay which is short circuited by a back contact on the relay. By this means, the current is reduced when the relay is picked up to a value approximating to that required to maintain it in the energised position.

7. The Primary—Secondary Relay Combination is designed on this principle except that the current remains constant and flux is altered. It consists of two relays in combination. The Primary relay is the track relay but differs from the conventional type in that it is fitted with coils having two specially balanced windings, one designed to provide the flux required to pick up the armature, and the other to provide the reduced flux required to hold the front contacts closed. The Secondary relay is the control relay and is energised separately over a front contact on the track relay. This relay is fitted with solid copper sleeves at the armature end of the magnetic core to delay its operation, and has four changeover contacts, one of which is a " make-before-break " which closes the holding circuit of the track relay before opening the pick-up circuit.

8. The circuit arrangements of a track circuit employing the Primary—Secondary combination is shown in Appendix A.

9. When the track circuit is clear, the hold-up winding only of the track relay is in circuit via the front contact of the make-before-break contact of the control relay. A resistance is included in this hold-up circuit to maintain the current the same as under pick-up conditions.

10. When the track circuit is occupied, both relays drop away but the shunt resistance is higher than with the conventional relay owing to the reduced voltage under hold-up conditions thus giving the increased shunting sensitivity

mentioned above. The pick-up coil of the track relay is now connected in circuit through the back contact of the " make-before-break " contact.

11. When the track circuit clears, the current flows through the pick-up coil of the track relay so that the flux per amp. is increased to the pick-up value and the track relay picks up. The control relay is now energised but its operation is delayed as mentioned above. When the control relay picks up the hold-up coil only of the track relay is again connected in circuit and the flux per amp reduced to the hold-up value.

ADVANTAGES OF THE PRIMARY-SECONDARY RELAY COMBINATION.

12. The main purpose of using the Primary-Secondary combination for low ballast track circuits is to take advantage of the increase in shunting sensitivity to increase the maximum ballast resistance at which the shunting effect will be satisfactory.

13. Two further advantages are gained by the introduction of a time delay during the pick-up of the control relay. The first is that momentary loss of shunt due to the rolling of light weight vehicles at speed does not cause the track circuit to show " clear " momentarily. The second is that short vehicles passing over a joint between two track circuits do not cause both track circuits to show clear momentarily. With the conventional track circuit, this is due to the pick-up time being less than the drop-away time so that the relay of the forward track circuit does not drop-away until after the relay of the rear track circuit has picked up, thus giving a short period during which the front contacts of both relays are made. The time delay on the pick-up of the control relay in the Primary—Secondary Combination ensures that pick-up and drop-away times are of the same order.

STABLE ADJUSTMENT.

14. The principles of stable adjustment have been adequately described in Technical Instruction No. C 1021. In this case, the same principles apply, except that the working range of ballast resistance is one ohm to infinity.

15. If the track circuit to be adjusted has a working range outside the range given, sufficient sections must be provided to bring the range of each section within the prescribed limits.

16. If it is found that the track circuit has a range outside that for which it is set, the test readings and a copy of the track circuit record card should be sent to the Area Office with a request for instructions.

17. Careful judgement is necessary in determining the ballast range of a particular track circuit, and the opportunity should be taken during extreme conditions of wet ballast to check the ballast resistance.

18. The principle of the method of adjustment is to arrange the feed resistance so that for the minimum ballast resistance of 1 ohm the Relay volts are at pick-up value.

TRACK FEED SET.

19. For track circuits having a minimum ballast resistance of 1 ohm, it is necessary for the supply voltage to be greater than for track circuits having a minimum ballast resistance of 2 ohms. It has been found that a voltage of at least 1.75 is required.

20. For primary cell track circuits, two sets of two 500 amp-hours caustic soda cells in series are therefore required.

21. For primary cell standby track feed sets, two 150 amp-hours caustic soda cells in series should be used.

22. For rectifier-fed track circuits, the style R.T.O. rectifiers rated at 1.4 volts 1 amp. maximum output or 2.5 volts 1 amp. maximum output are suitable. It should be noted that the former type has an output voltage greater than 1.75 on loads up to 0.8 amps which is higher than is likely to be required.

23. The internal resistance of the above mentioned rectifiers forms a portion of the feed end resistance. In the feed resistance calculation an allowance of 2.2 ohms and 1.3 ohms has been made for the 1.4 volt and 2.5 volt rectifiers respectively.

EFFECT OF RELAY LEAD RESISTANCE.

24. For track circuits having minimum ballast resistances less than 2 ohms, the effect of relay lead resistance is appreciable. Relay lead resistance obviously increases the rail volts for the same relay volts, thus necessitating a lower feed resistance for the same minimum ballast resistance. When the track dries out to the maximum ballast resistance, the shunt is less owing to the higher rail volts and may be less than the permissible minimum of 0.5 ohm.

25. For the minimum ballast resistance of 1 ohm, the maximum permissible relay lead resistance is found to be 3 ohms. Up to a maximum of 15 yards of 7/.029 may be considered to have negligible resistance at the relay end.

26. The relay lead resistance may be determined from the chart shown in Appendix B.

METHOD OF ADJUSTING TRACK CIRCUIT.

27. The feed resistance required will vary according to the type of feed set and relay lead resistance. The appropriate feed resistances for the Primary—Secondary relay combination are given in Appendix C.

28. The feed end resistance should be determined from the tables for the particular feed set with which the track circuit is equipped.

29. The method is best illustrated by the following example :—

Example.

Rectifier/Primary Cell Track Feed Set.

Data :—

Ballast Resistance range	=1 ohm to infinity ohms.
Primary Cell volts	=2.6 to 1.9 (2 cells in series).
Rectifier rated volts	=1.4 volts (at 1 amp).
Length of track circuit	=800 yards.
Length of Feed Leads	=10 yards (7/.029) each lead.
Length of Relay Leads	=90 yards (7/.029) each lead.

Procedure.

(1) From Appendix B.
Relay lead resistance =1.0 ohm.
Feed lead resistance =0.1 ohm.

(2) From Appendix C (Primary Cell Track Feed Set with Relay lead Resistance=1.0 ohm.)
Combined feed resistance=3.6 ohms.

(3) Deduct feed lead resistance as follows :—
Combined feed resistance=3.6 ohms.
Less feed lead resistance =0.1 ohm.

Required feed resistance setting =3.5 ohms.

(4) Set Primary Cell feed resistance to 3.5 ohms.

(5) From Appendix C (1.4 volt Rectifier Track Feed Set with Relay lead resistance=1.0 ohms.)
Combined feed resistance=6.3 ohms.

(6) Deduct feed lead resistance as follows :—
Combined feed resistance =6.3 ohms.
Less feed lead resistance =0.1 ohm.

Required feed resistance setting =6.2 ohms.

(7) Set Rectifier feed Resistance to 6.2 ohms.

OPERATION OF THE TRACK CIRCUIT AFTER ADJUSTMENT.

30. In order that the operation of the track circuit after a stabilised adjustment should be clearly understood by all concerned, Appendix D has been compiled for the foregoing example.

31. In the appendix referred to, Relay Volts and Drop-away shunt resistance have been plotted against Ballast Resistance.

32. It will be noticed that the track circuit will shunt at a value greater than 0.5 ohm within the limits of feed voltage shown. For any feed voltage within these limits, the Relay Volts and Drop-away shunt will vary with Ballast Resistance in a similar manner.

33. If reference is made to the curves, it will be noted that if the feed voltage is greater than the stipulated maximum of 2.6 volts, the D.A. shunt will become less than 0.5 ohm at some value of ballast resistance less than the upper limit of the working range.

34. Similarly, if the feed voltage falls below the stipulated minimum of 1.9 volts, the relay volts will become less than the pick-up value at some value of ballast resistance greater than the lower limit of the working range.

35. It is therefore important to see that the cell voltage is within the stipulated working limits and that rectifiers are adjusted to the voltage given.

36. It will be found that the D.A. shunt will be different at each end of the track circuit. When the total feed end resistance is less than the total relay end resistance, the feed end shunt will be less than the relay end shunt and *vice versa*.

BASES ON WHICH THE ADJUSTMENT TABLES HAVE BEEN COMPILED.

37. The calculations have been based on the following assumptions :—

(1) Minimum D.A. Shunt to be not less than 0.5 ohm.

(2) Ballast resistance range of track circuit to be 1 to infinity ohms.

(3) Rail resistance less than 0.15 ohm per 1000 ft. (Two rails).

(4) Primary—Secondary Relay characteristics.
Primary Relay :—
Resistance =3.85 ohms.
Pick-up volts =0.252 volt.
Drop-away volts =0.2195 volt.

Secondary Relay :—
Resistance =422 ohms.
Maximum Pick-up Volts=6.9 volts (1.88 secs. slow P.U.)
Minimum Pick-up Volts=5.7 volts (3.27 secs. slow P.U.)

Note.—The Secondary relay characteristics have no bearing on the track circuit adjustment.

(5) Primary cell volts=2.6 to 1.9 for 2 cells in series (on load).

(6) Rectifiers adjusted to give the following output voltages on 0.5 amp load :—

Style R.T.O. 1.4 volt type :—2.5 to 2.6 volts (3.7 volts effective Internal).

Style R.T.O. 2.5 volt types :—2.1 to 2.2 volts (2.85 volts effective Internal).

38. With the low values of ballast resistance encountered on the track circuits for which this instruction is intended, the effect of the distributed leak is appreciable and all calculations have been made on this basis.

USE OF AN ALTERNATIVE TYPE OF RECTIFIER.

39. The load characteristics of Style R.T.O. on which the calculations have been based are shown in Appendices E and F. The effect of the internal resistance of the rectifier is important. In the type chosen the internal resistance is constant over the normal working load of the rectifier and forms a part of the feed end resistance.

40. If it is necessary to use a different type of rectifier from that given, it is essential to use one with similar effective internal voltage, and with constant internal resistance over the working load.

41. In such cases, the given feed resistance adjustment may be different from that given in the tables and must be determined afresh. A load characteristic for the alternative rectifier should first be plotted, and, from it, the effective internal voltage and internal resistance over the working range should be determined. Assuming the internal voltage on one of the transformer taps is suitable, the procedure for calculating the new value of feed resistance is as shown in the following example :—

Example.

To calculate the value of feed resistance required, given that an alternative form of rectifier similar to the 2.5 volt type (*i.e.*, having an effective internal voltage of 2.85) is to be used.

(1) **Determine Effective Feed end Resistance.**

Effective Internal resistance of 2.5 volt rectifier	=1.3 ohms.
Combined Feed end resistance, say	=3.2 ohms.
Total effective feed end resistance	=4.5 ohms.

(2) **Deduct Internal Resistance of Alternative Rectifier.**

Total effective feed end resistance	=4.5 ohms.
Less effective internal resistance of alternative rectifier (from load characteristic), say	=1.9 ohms.
Combined feed end resistance	=2.6 ohms.

42. It should be noted that the effective internal voltage and resistance of the rectifier must be determined from the straight portion of the characteristic at the appropriate load range and not from an open-circuit test. This will be evident from the form of the load characteristic curve which rises steeply towards no load.

CONCLUSION

43. In setting up the Track Circuit, particular attention should be given to obtaining the resistance of the feed leads as accurately as possible.

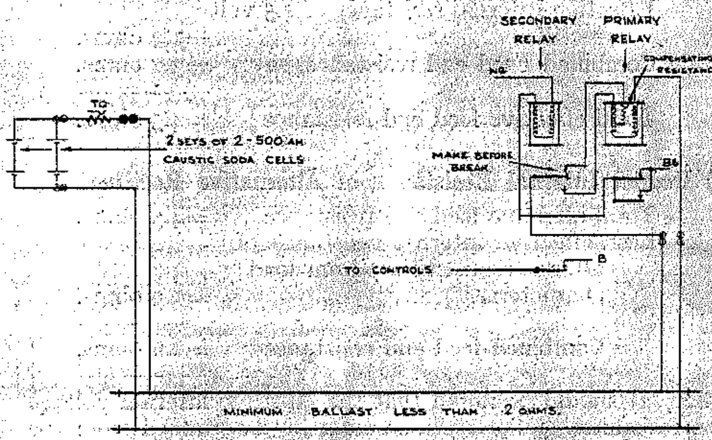
44. In cases where the Rectifier/Primary Cell Standby feed set is used, the resistance of the de-energised contact on the Power-Off Relay is a possible cause of failure, and if the voltage drop across it (when the Primary Cell is in use) exceeds 0.1 volt, the Relay should be changed.

45. Particular attention is also necessary to see that the Rectifier is adjusted to the correct voltage.

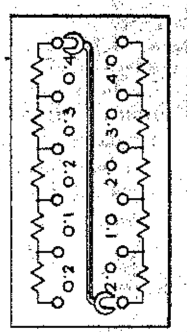
46. Although a stabilised adjustment will, if correctly carried out, eliminate track circuit failures due to weather conditions, drop shunt tests should be made at least once a month.

47. It is particularly important that the maximum length of the track circuit and maximum relay lead resistance should not, in any circumstances, be exceeded.

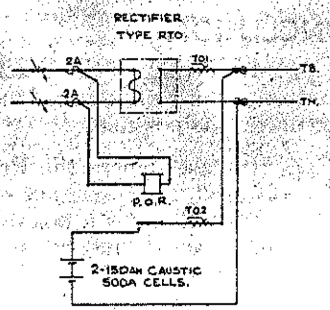
APPENDIX A.



TRACK CIRCUIT WITH PRIMARY - SECONDARY RELAY COMBINATION AND PRIMARY CELL TRACK FEED SET.



TRACK FEED RESISTANCE INTERNAL CONNECTIONS.



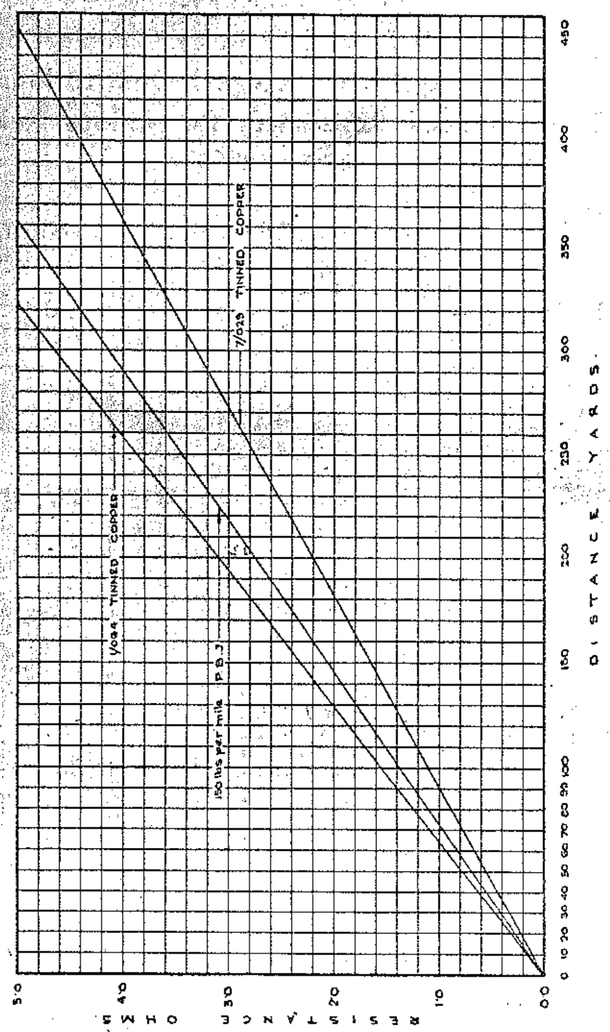
RECTIFIER/PRIMARY CELL STANDBY TRACK FEED SET

D.C. TRACK CIRCUITS.

PRIMARY / SECONDARY SET.

TRACK FEED SETS.

APPENDIX B.



D.C. TRACK CIRCUITS.

FEED AND RELAY LEADS.

RESISTANCE/DISTANCE GRAPH.

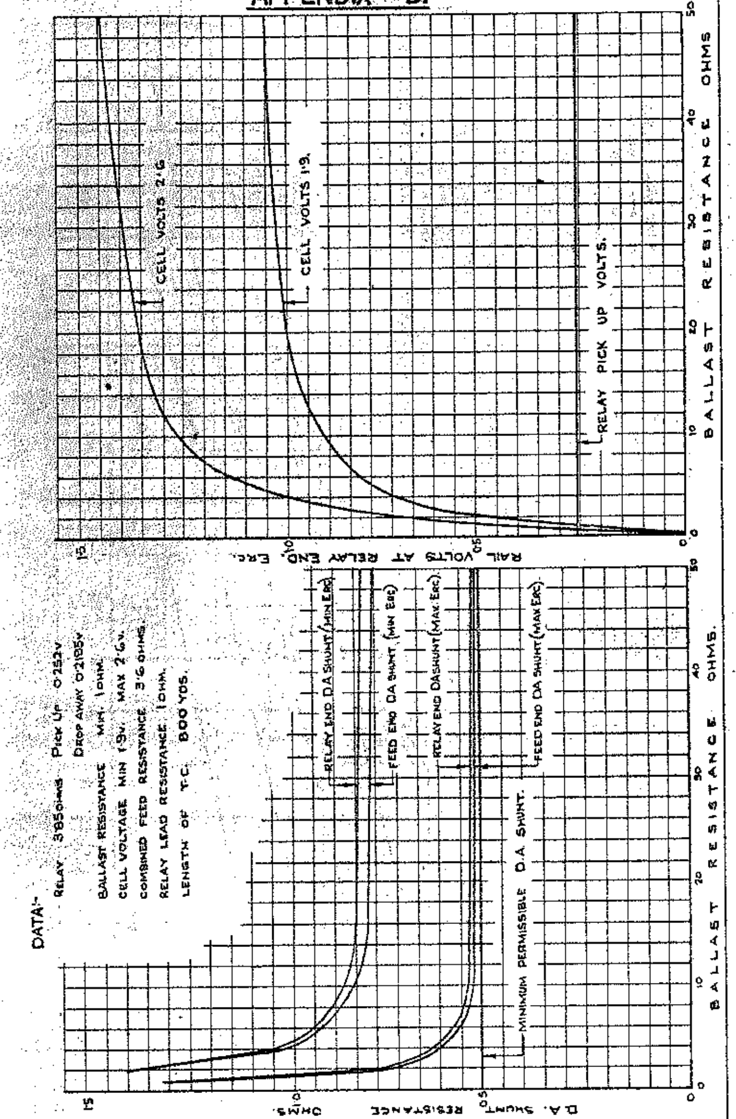
FOR PAIR OF CONDUCTORS.

Appendix C

D.C. Track Circuits
Primary Secondary Relay Combination
Ballast Resistance Range 1 Ohm to Infinity
Table of Feed Resistances for various Relay lead Resistances

Relay Lead Resistance	Primary Cell Feed Set. Length of T.C. in Yards: 0	200	400	600	800	1000	Rectifier Feed Set: 2.5 volt type	1.4 volt type
0	4.8	4.8	4.7	4.6	4.5	4.4		
.1	4.7	4.6	4.5	4.4	4.3	4.3		
.2	4.6	4.5	4.4	4.3	4.2	4.2		
.3	4.5	4.4	4.3	4.2	4.1	4.1		
.4	4.4	4.3	4.2	4.1	4.1	4.0	4.5	6.3
.5	4.3	4.2	4.1	4.0	4.0	3.9		
.6	4.2	4.1	4.0	3.9	3.9	3.8		
.7	4.1	4.0	3.9	3.8	3.8	3.7		
.8	4.0	3.9	3.8	3.7	3.7	3.6		
.9	3.9	3.9	3.8	3.7	3.7	3.6		
1.0	3.9	3.8	3.7	3.6	3.6	3.5		
1.1	3.8	3.7	3.6	3.5				
1.2	3.7	3.6	3.5	3.4				
1.3	3.6	3.6	3.5	3.4			3.7	3.8
1.4	3.6	3.5	3.4	3.3				
1.5	3.5	3.4	3.3	3.2				
1.6	3.4	3.4	3.3	3.2				
1.7	3.4	3.3	3.2	3.1				
1.8	3.3	3.2	3.2	3.1				
1.9	3.2	3.1	3.1	3.0				
2.0	3.2	3.1	3.1	3.0				
2.1	3.1	3.0						
2.2	3.1	3.0						
2.3	3.0	2.9					2.9	3.0
2.4	3.0	2.9						
2.5	2.9	2.8						
2.6	2.9	2.8						
2.7	2.8	2.7						
2.8	2.8	2.6						
2.9	2.7	2.6						
3.0	2.7	2.6						

APPENDIX D.



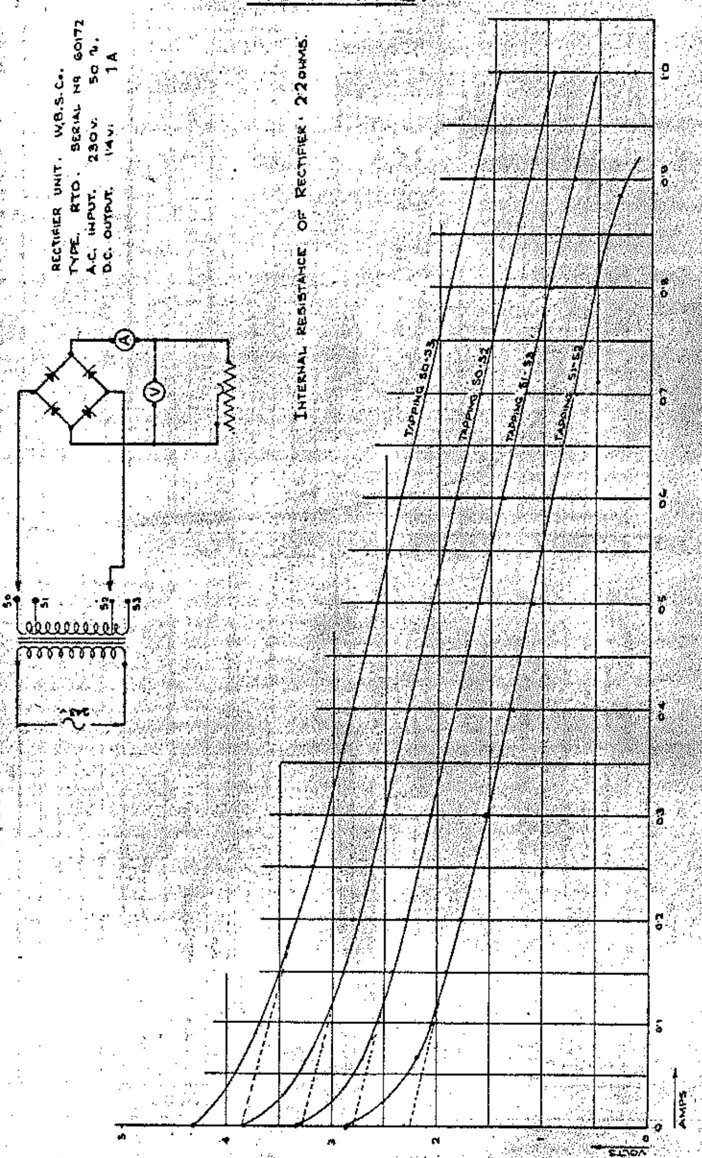
D.C TRACK CIRCUITS.

PRIMARY / SECONDARY SET.

VARIATION OF D.A. SHUNT AND RELAY VOLTS WITH BALLAST RESISTANCE

EXAMPLE.

APPENDIX E.

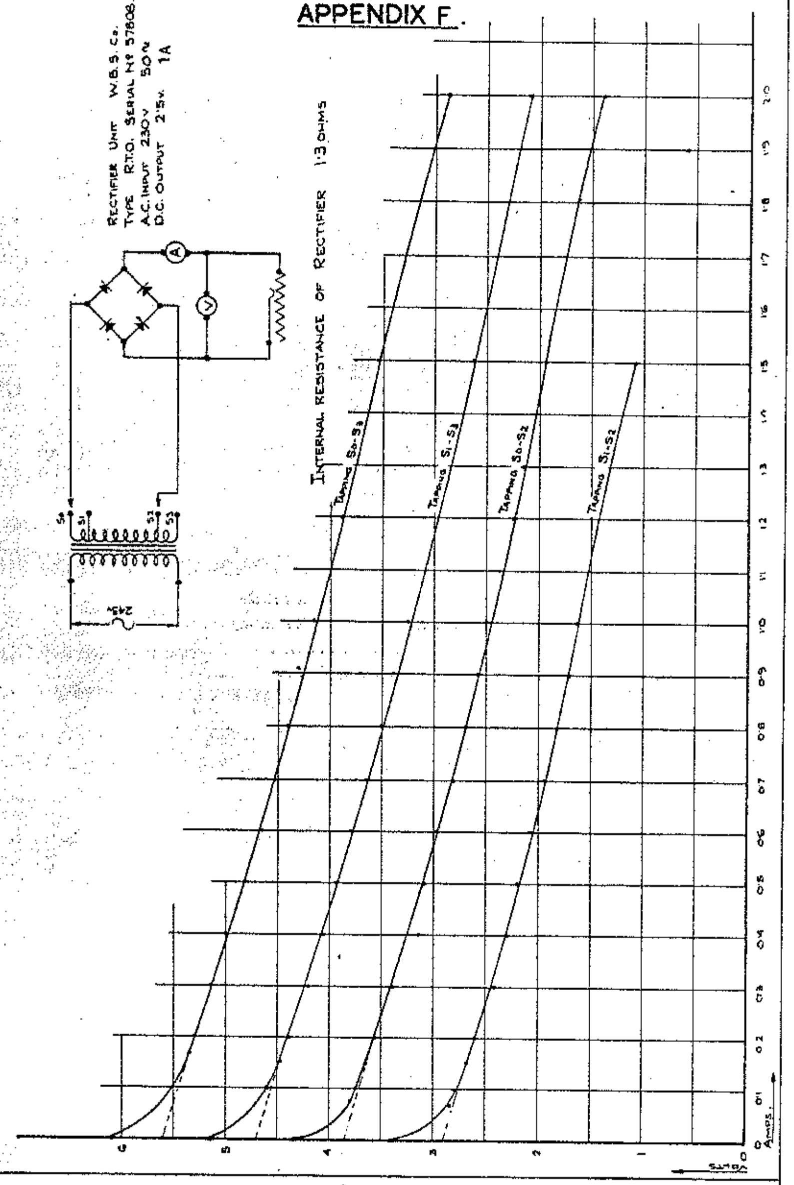


METAL OXIDE RECTIFIERS.

LOAD CHARACTERISTICS OF

COPPER OXIDE TYPE 1·4 VOLT SET.

APPENDIX F.



METAL OXIDE RECTIFIERS.

LOAD CHARACTERISTICS OF

COPPER OXIDE TYPE 2·5 VOLT SET.

L.N.E.R. **C.1041.**

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

SIGNALLING—ELECTRICAL.

D.C. Track Circuits.

Standard method of adjustment of high voltage type.

GENERAL

1. In certain localities a high resistance film may exist on the rails under normal conditions. In such cases, the low voltage track circuits described in C.1021 and C.1031 will not shunt satisfactorily because the rail voltage is insufficient to break down the film. The high voltage type to be described must then be installed.

2. The film may be caused by sanding, rust due to infrequent traffic or rust due to brine from fish wagons. In the case of sanding, it should be ascertained whether the trouble is due to dry or steam sanding and if the former, the matter should be reported to the District Superintendent's Office because in such cases, the film is likely to increase to such an extent that even the high voltage track circuit will not shunt satisfactorily.

3. Tests have shown that a normal sand or rust film has a definite breakdown voltage above which its resistance is reduced. This voltage is in the neighbourhood of 3 volts and the high voltage track circuit has been designed to have a rail voltage greater than this figure under normal ballast conditions.

4. The high voltage D.C. type is also suitable for the long track circuits required for single lines worked by direction levers.

DESCRIPTION OF THE HIGH VOLTAGE D.C. TRACK CIRCUIT

5. The standard high voltage D.C. track circuit consists of a feed set having an output of not less than 5.5 volts with a 6 ohm fixed feed resistance, and a 2.5 ohm track relay with a 10 ohm. variable series relay resistance.

6. The feed set should be of one of the following types :—

(*a*) Two sets of six primary cells in parallel, used where no power supply is available and the track circuit is to be continuously fed.

(*b*) One set of six primary cells, used where no power supply is available and the track circuit is to be intermittently fed.

(*c*) Rectifier/primary cell type in which a single set of six primary cells acts as a standby to a rectifier-fed track circuit and is brought into service when a power failure occurs.

These feed sets are shown in the accompanying Appendices A and B.

7. The primary cells are of the air-depolarising caustic soda type, each having a capacity of 500 amp-hours (zinc life).

8. The Rectifier may be of either the copper-oxide or selenium cell type. It should be suitable for resistance loads and be rated at 6 volts 1.5 amps. maximum output and internal resistance not exceeding 1.5 ohms.

9. The " Power-Off " Relay is connected directly across the power lines and its release, on a power failure, connects the standby battery to the track circuit.

10. Owing to the high supply voltage, it has been found that normally a resistance of 6 ohms will be suitable for feed sets for track circuits up to 1,200 yards in length. A fixed resistance is therefore used, except where the feed resistance exceeds 0.5 ohm.

11. The track relay is the standard D.C. neutral 10 ohm type with coils connected in parallel to reduce its resistance to 2.5 ohms.

12. The effect of parallelling the coils is to halve the operating voltage and double the current. The ratio of drop-away to pick-up voltage remains the same, viz. 70%.

The relay operating figures are thus altered as follows :—

	10 ohm Relay	2.5 ohm Relay
P.U. Volts	0.39	0.195
D.A. Volts	0.27	0.135
P.U. Amps.	0.039	0.078
D.A. Amps.	0.027	0.054

13. The 10 ohm series relay resistance has the effect of increasing the operating voltages to 0.975 (pick-up) and 0.675 (drop-away) and the effective relay end resistance to 12.5 ohms.

14. The series relay resistance is variable so that relay lead resistance may be compensated for by a suitable reduction.

ADJUSTMENT OF THE TRACK CIRCUIT

15. The feed resistance being fixed, the only adjustment required in setting up the track circuit is to set the series relay resistance to such a value as will give a total of 10 ohms in series with the relay.

16. The resistance of the relay leads may be readily determined from the chart given in Appendix C and by deduction from 10 will give the value to which the series resistance should be set.

17. It is, of course, important that the output voltage of the battery and rectifier should be checked. The battery voltage should be within the limits of 5.7 to 8 volts (this is based on an initial cell voltage of 1.3, falling to 0.95). The rectifier voltage (on load) should be within the same limits.

18. The feed lead resistance will not have any effect on the adjustment unless it exceeds 0.5 ohm in which case a standard variable resistance should be substituted for the 6 ohm fixed resistance. The actual feed lead resistance should then be determined by the chart in Appendix C and subtracted from 6. The feed resistance should be set to the resultant figure.

19. The procedure in setting up the high voltage track circuit is best illustrated by an example :—

Data :—

Primary battery volts—8 to 5.7 (6 cells in series).

Length of Track Circuit—800 yards.

Length of Relay Leads—90 yards (7/.029) each lead.

Length of Feed Leads—10 yards (7/.029) each lead.

Procedure :—

1. From Appendix C.

   Relay lead resistance—1.0 ohm.
   Feed ,, ,, —0.1 ohm.

2. Deduct relay lead resistance from combined relay end resistance as follows :—

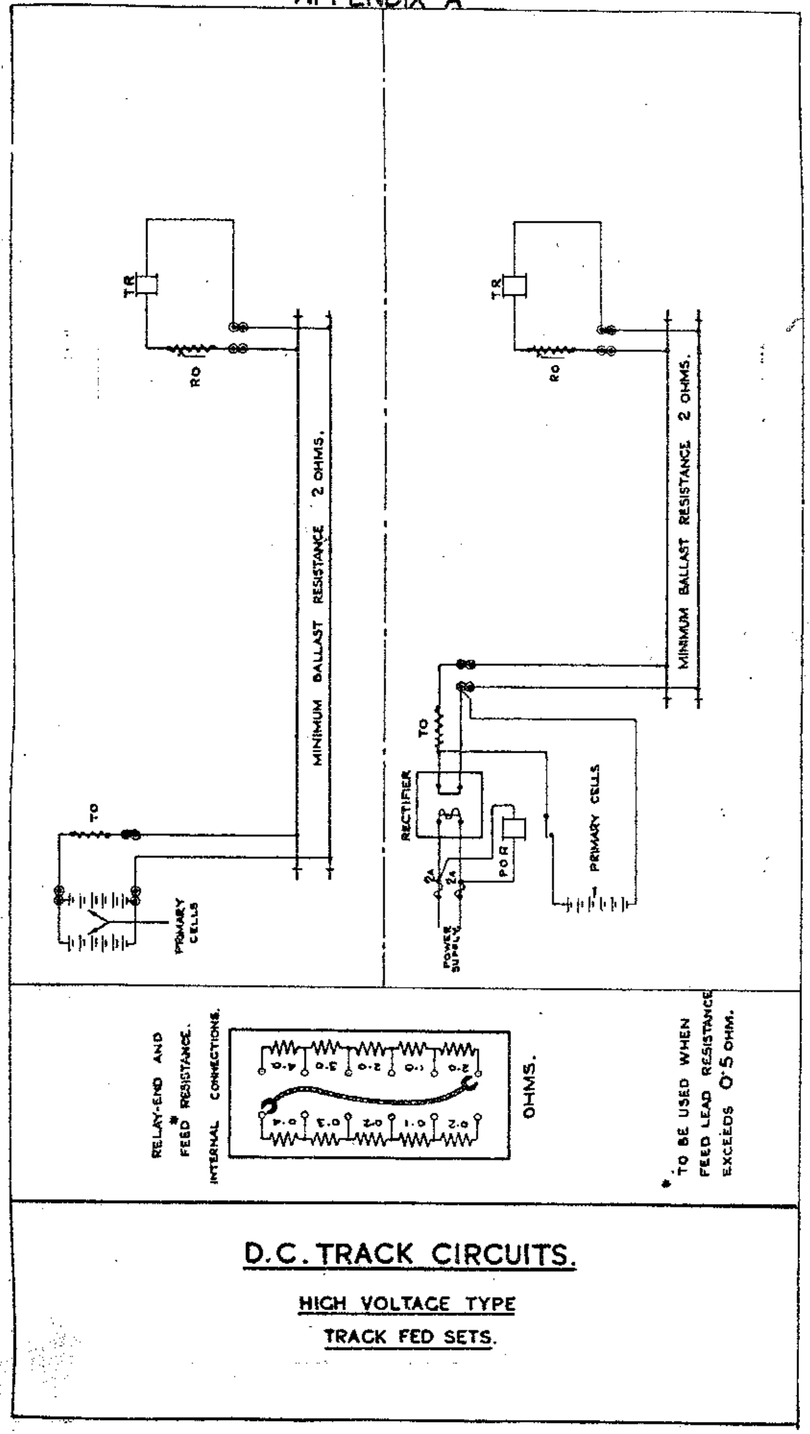
   Combined relay end resistance—10.0 ohms.
   Less Relay lead resistance —1.0 ohm.

   Relay end resistance setting —9.0 ohms.

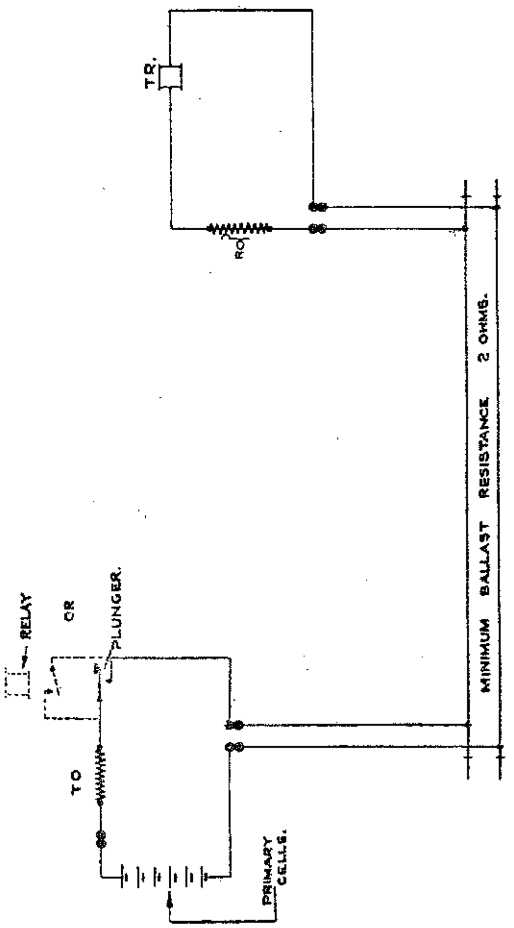
3. Set relay end resistance to 9.0 ohms.

4. As feed lead resistance is less than 0.5 ohm, the 6 ohm fixed feed resistance will be satisfactory.

APPENDIX A



APPENDIX B



D.C. TRACK CIRCUITS.

HIGH VOLTAGE TYPE

FOR INTERMITTENT OPERATION.

20. The operation of the track circuit used in the above example is shown in Appendix D, which shows the effect of varying Ballast Resistance on the Relay Volts and Drop-away Shunt Resistance.

21. The method described above will give a stable adjustment on any length of track circuit up to 1,200 yards, provided the ballast resistance does not fall below 2 ohms.

INTERMITTENT OPERATION

22. It will be realised that in raising the rail voltage, the normal current drain through the ballast has been considerably increased, and, in consequence, the high voltage track circuit is expensive to operate.

23. In certain situations where it may not be necessary to provide an indication on the Signal Box diagram, e.g. long track circuits on direction-lever operated single lines or isolated track circuits replacing lock bars on switches. In such cases, a push button or catch handle contact may be used to energise the track, only at the time the lever lock is released. This arrangement is shown in Appendix B. A relay may be used for the same purpose where it is economical to do so.

CONCLUSION

24. In cases where the Rectifier/Primary Battery standby feed set is used, the resistance of the de-energised contact on the Power-Off Relay is a possible cause of failure, and if the voltage drop across it (when the Primary Battery is in use) exceeds 0.3 volt, the relay should be changed.

25. Although a stabilised adjustment will, if correctly carried out, eliminate track circuit failures due to weather conditions, drop shunt tests should be made at least once a month.

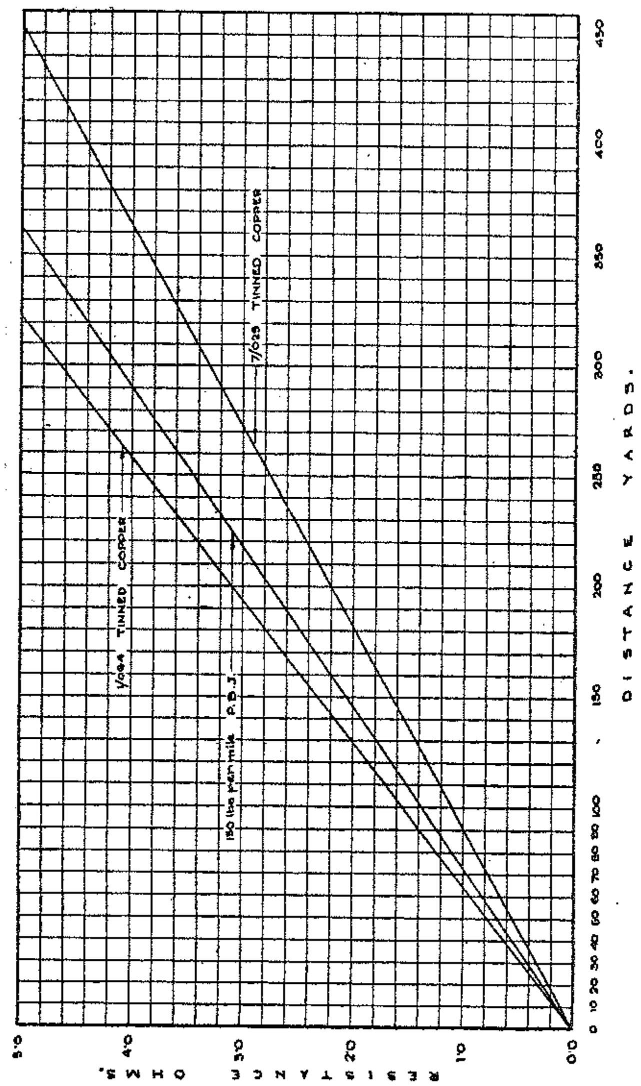
26. It is particularly important that the fixed feed resistance should not be used in cases where the feed lead resistance exceeds 0.5 ohm.

27. The maximum length of 1.200 yards is based on screw chair fastenings. If through-bolted track is used, the maximum permissible length of the track circuit may be as low as 400 yards, except where insulated bolts are used, in which case the limit may be 800 yards provided the insulations are in good order.

Reference: A.C.E. (S) Conference Note No. 27. 25.2.46.

Approved by Chief Engineer 10.4.46.

APPENDIX C



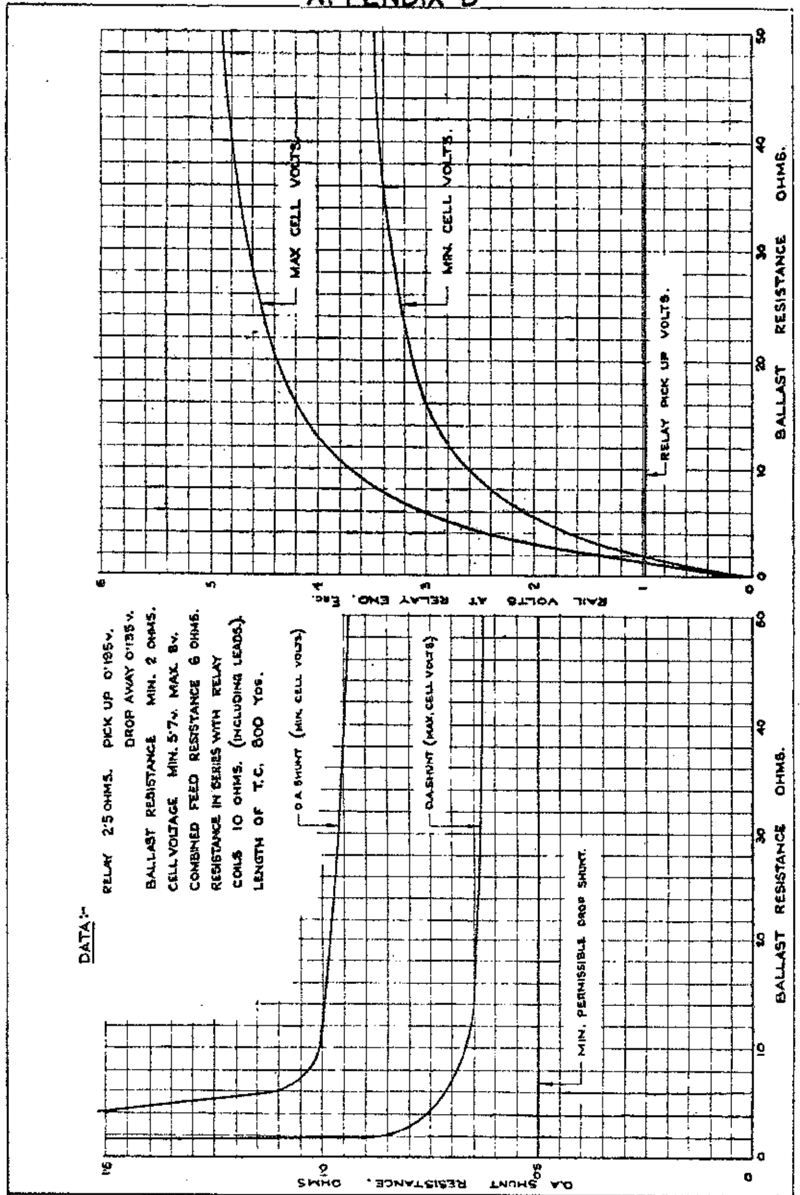
D.C. TRACK CIRCUITS.

FEED AND RELAY LEADS.

RESISTANCE DISTANCE GRAPH

FOR PAIR OF CONDUCTORS.

APPENDIX D



D.C. TRACK CIRCUITS.

HIGH VOLTAGE TYPE.

VARIATION OF D.A. SHUNT & RELAY VOLTS WITH BALLAST RESISTANCE

EXAMPLE.

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L.N.E.R. Company's Printing Works,
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L.N.E.R.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

C.1090.

SIGNALLING—ELECTRICAL.

Track Circuits.
Track Circuit Interrupter.

GENERAL

1. In track circuited areas, track circuit interrupters are fitted at Trap or Catch Points in order to ensure that the track circuit concerned will show "occupied" should anything be derailed at these points.

2. The position in which the Interrupter must be fixed and the relative location of insulated rail joints is set out below, according to the type of layout and its position relative to the track circuit.

LOCATION OF INSULATED JOINTS

3. In order to cover the possibility of a breakdown of the insulated joints, when used in connection with a track circuit interrupter, all future installations must have the insulated joints arranged in relation to the interrupter as shown in Appendix A.

4. Five typical examples of the location of the interrupter and insulated joint are shown in Appendix A, together with the necessary cable jumpers.

LOCATION OF INTERRUPTER

5. Particular attention is drawn to the necessity of locating the track circuit interrupter in proper relation to the running rail.

6. The interrupter must never be placed so that there is room for a vehicle to stand clear of the interrupter but foul of the running line, since a false clear might occur if the run-off rails were rusty.

7. Except for D and E switches, the interrupter must be fixed between the 2P (R or L) and 3P (R or L) chairs, as shown for a typical case in Appendix B. This instruction applies to all types of Trap Points.

8. In the case of D and E switches, when used as Trap Points, the interrupter must be fixed between the 4P (R or L) and 5P (R or L) chairs for D switches and between the 7P (R or L) and 8P (R or L) chairs for E switches.

9. In all cases, the Insulated Joint, as shown in Appendix B, should be fitted between the last P chair and the L1 chair; in the case of D and E switches, this will necessitate the switch rail being lengthened or a closure rail used, as specified on the Standard Permanent Way Drawings.

Reference A.C.E. (S) Conference Minute No. 31/46.

Authorised by Chief Engineer. 26.6.46

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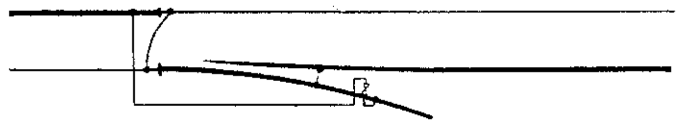
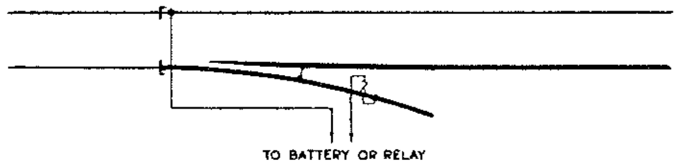
4335/6/46 250

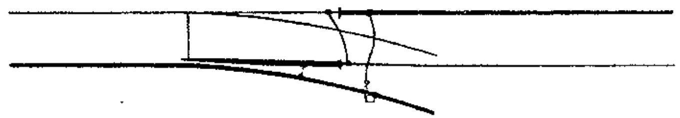
APPENDIX A



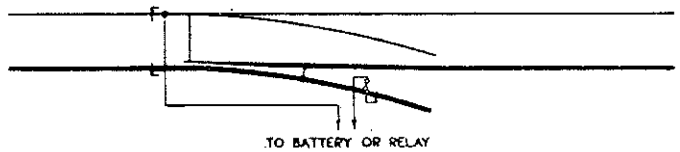
SINGLE SWITCH POINT. INTERMEDIATE POSITION. 1



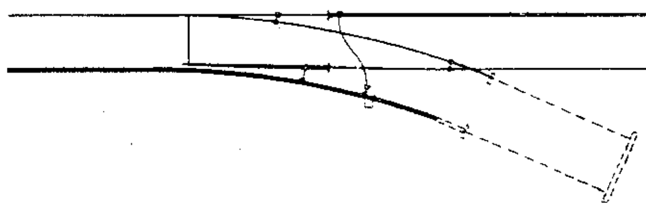
SINGLE SWITCH POINT. END POSITION. 2



DOUBLE SWITCH POINTS. INTERMEDIATE POSITION. 3



DOUBLE SWITCH POINTS. END POSITION. 4



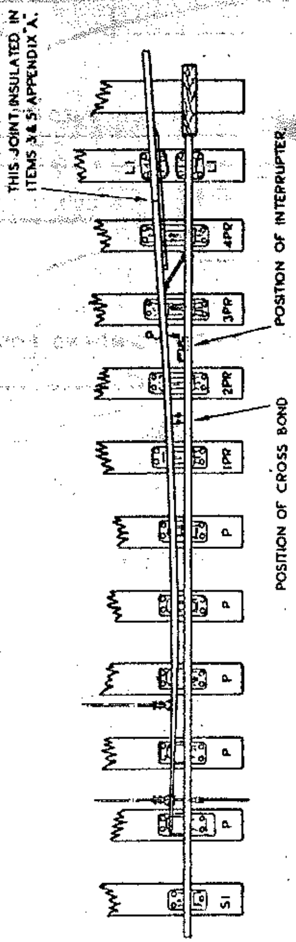
DOUBLE SWITCH POINTS. (WITH SPUR SHOWN DOTTED) 5

TRACK CIRCUIT INTERRUPTER.

TYPICAL EXAMPLES SHOWING

POSITIONS OF INSULATED RAIL JOINTS & JUMPERS.

APPENDIX B.



TRACK CIRCUIT INTERRUPTERS.

TYPICAL CASE SHOWING POSITION

FOR FIXING INTERRUPTER.

L.N.E.R.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

C.1401.

SIGNALLING—ELECTRICAL.

Relays and Signal Mechanisms.

Changing, Recording and Handling.

PERIODIC CHANGING

1. All relays used for Signalling purposes must be forwarded to the Area Workshops for periodical overhaul at 5-yearly intervals.

2. This instruction applies equally to searchlight signal mechanisms, which may be regarded as 3-position relays for the purpose of overhaul.

CHANGING (OTHER THAN PERIODIC)

3. In the event of any irregularity in the working of a Relay, it must be changed immediately this is discovered and forwarded to the Area Workshops with an explanatory note. The District Inspector concerned must also be advised.

4. Should the drop-away value of a D.C. Track Relay be found, on test, to be less than 60 per cent. of the pick-up value, the relay must be taken out of service and sent to the Area Workshops as stated in the preceding paragraph.

5. The Section Lineman is the person normally responsible for changing a relay or Signal Mechanism, and he must make all reasonable tests of the circuits involved, after the change has been effected, to ensure that the wiring is still in accordance with the diagram.

RECORD

6. Whenever a relay is installed or changed, the Relay Record Number and details of the location must be noted and sent to the Area Office on the card (Form No. E.453) provided for that purpose.

7. When installing Track Relays, the Record Number should be entered on the front page of the Track Circuit Record card, with the date of installation, in addition to the record mentioned above.

HANDLING OF RELAYS

8. The seals of relays must not be broken by anyone except the authorised person/s at the Area Workshop.

9. All relays suspected of being the cause of False Clear failures must be handled with great care, when being forwarded for examination, in order to minimise the chance of evidence (as to the cause of failure) being destroyed. An explanatory note should be sent with the relay/s.

10. When forwarding relays to the Workshops, they should be carefully packed, preferably in wooden boxes, so as to prevent damage (*e.g.*, Stores boxes that are being returned after delivery of Stores may be conveniently used for this purpose).

11. Whenever relays are being returned to Stores or otherwise moved over long distances, the transport screw must be used.

12. In the case of relays that have been subject to False Clear failures or where there are other exceptional circumstances, the relay should be returned to the Workshop by hand. In such cases the instructions in paragraphs 10 and 11 with regard to packing and transport screws will not apply.

CREDIT NOTES

13. The Credit Note accompanying any relay changed under the above instructions should be marked "For Overhaul."

Reference A.C.E. (S) Conference Minute No. 31/46.

Authorised by Chief Engineer. 26.6.46

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L.N.E.R. **E. 1001.**

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

TRANSMISSION
Overhead Lines.
Type of Wire Used for Various Functions.

GENERAL

1. The type of line wire to be used for the various types of circuits, having regard to the atmospheric conditions, is set out below.

2. The choice of wire depends primarily on transmission requirements and the sizes shown are the minimum sizes for the transmission standard required. An increase in size may have to be made to suit other conditions as shown in the following paragraphs.

DEFINITION

3. Main trunk lines and important telegraph circuits are those which are 100 miles or more in length. Other trunk lines and telegraph circuits are classified as Short Trunks and less important telegraph circuits.

4. Bare overhead copper wire is to be used as indicated in the following table :—

Type of Circuit	Class of Wire for Locality			Resistance per mile in ohms	Breaking Load in lbs.
	Normal	Exposed*	Industrial †		
Main Trunks ..	HDC 200 (B.S. 174)	HDC 200 (B.S. 174)	HDC 200 (B.S. 174)	4·5	645
Short Trunks, important telegraph ccts and Train Control circuits	HDC 150 (B.S. 174)	Cd. Cu.150 (B.S. 175)	HDC 200 (B.S. 174)	5·9 7·0 4·5	490 696 645
Block ccts., S.B. telephones, signal repeaters, telephone extns., less important telegraph ccts	Cd.Cu.100 (B.S. 175)	Cd.Cu.100 (B.S. 175)	HDC 150 (B.S. 174)	10·5 10·5 5·9	479 479 490

* Covers exposed situations in both coastal and inland localities.

† Includes routes over Locomotive Depots.

5. Covered wire of the following types will be used for signalling control circuits, power lines and as suspender wire as directed on the circuit diagrams:—

(*a*) For Signalling Control Circuits: 150 lb. Cadmium Copper P.B.J. or 200 lb. H.D.C. P.B.J.

(*b*) For Power Lines: 200 lb. H.D.C. P.B.J.

(*c*) For Suspender Wire:

(i) 400 lb. (GSL 400 to B.S. 182) steel jute covered.

(ii) 3 x No. 8 (GSS 2 to B.S. 183) steel jute covered for heavy routes.

(iii) For short distances, such as lead-in spans, it is permissible to use 150 lb. or 200 lb. P.B.J. wire.

Reference— A.C.E. (S) Conference Note No. 3—25.2.46.

Authorised by Chief Engineer—10.4.46.

LNER 6153/8/46 250

L.N.E.R. E. 1002

Chief Engineer's Department
Technical Instructions
Signalling and Communications

TRANSMISSION
Overhead Lines
Regulation of Line Wires
Method of Checking

GENERAL

1. The purpose of this instruction is to describe a method which may be used by Inspectors for checking the regulation of line wires.

2. Correct regulation of wires is essential to avoid (*a*) excessive tension which increases chances of breakage particularly in cold weather when the wires are tightest and (*b*) excessive slackness which increases contact faults particularly in hot weather when sag or dip is greatest.

3. Correctness of regulation is judged by the amount of sag or dip.

4. The factors which determine how much dip should be allowed are :—

(*a*) Temperature
(*b*) Span
(*c*) Type of wires.

Note.—The weight per mile of conductor has no effect on the dip allowable. For the same dip, the tension of a heavy wire is greater than that of a light wire but the greater strength (owing to its greater cross-sectional area) compensates for this.

5. When more than one type of wire, *e.g.*, copper and cadmium-copper, exist on the same route, the dip has to be adjusted to a compromise value. This is necessary because of the differences of mechanical properties and rates of expansion for temperature changes of different metals.

6. When erected, all wires in any one span should (subject to para. 7 below), be adjusted to the same dip, but it should be noted that owing to the differences between different metals, small differences of dip may be noticeable at temperatures other than that at which the wires were adjusted.

7. When P.B.J. wires are run under bare wires, the bare wires will be adjusted to the appropriate dip according to Table A (1) or (2) and the P.B.J. wires independently adjusted to Table A (3).

8. P.B.J. wires will, whenever possible, be kept at the bottom of the bed, but if it has been impossible to avoid P.B.J. wires among the bare wires, the whole of the bed should be adjusted to Table A (4).

9. Where P.B.J. wires are adjusted to Table A (3), bare common returns run with the P.B.J.'s can be adjusted to the same dip as the latter.

10. A table showing the dip for the most likely conditions, Table A, is attached. Area office should be consulted if particulars are required for conditions not covered by this table.

METHOD OF CHECKING DIP.

11. The following method of checking dip, known as the "swinging" or "pendulum" method can be used as an alternative to judging dip by sighting from arm level, or from the ground. The method is only practicable when the air is comparatively still.

12. Swing the wire, so that it moves as a whole and not in sections, by either of the following methods as convenient:—

(*a*) From arm level swing the wire by hand, being careful to apply the impulses in time with the natural time of the swing of the wire.

(*b*) From ground level the wire can be drawn aside at the centre of the span by means of a rod and then released.

13. The amplitude of the swing should be such that at least twenty distinct swings can be counted before the movement dies out.

14. The time for twenty **complete** swings is taken as accurately as possible, preferably by use of a stop watch. If a stop watch is not available, a seconds hand watch should be used and a second person should take the time whilst the first counts the swings.

15. The amount of dip can then be determined by reference to Table B.

16. If the time taken for twenty complete swings is less than that shown for the correct dip (ascertained from Table A) the wire is **too tight** and must be slackened and the dip again checked.

17. If the time taken for twenty complete swings is **more** than that shown for the correct dip, the wire is **too slack** and must be tightened up and checked again.

18. The above procedure must be repeated if necessary until the correct time for twenty complete swings is obtained.

Reference :—A.C.E. (S) Conference Minute No. 88/45.
Authorised by Chief Engineer 4-7-45.

TABLE A

Temperature	DIP IN INCHES															
	(1) Copper only, Iron only, Copper and Iron				(2) Cadmium-Copper and Copper or Iron				(3) PBJ Copper only, and bare copper common returns *				(4) Bare wire of any metal and PBJ			
	Span. Yds.				Span. Yds.				Span. Yds.				Span. Yds.			
	55	60	65	70	55	60	65	70	55	60	65	70	55	60	65	70
Very cold (Approx. 20 °F)	11	13	15	18	8	9	11	12	18	21	25	29	15	18	20	24
Cold (Approx. 40 °F)	13	15	18	21	9	10	12	14	21	24	28	33	17	21	24	28
Normal (Approx. 60 °F)	16	18	22	25	10	12	14	16	24	27	32	36	20	24	28	33
Hot Approx. 80 °F)	19	22	26	30	12	14	16	19	27	31	35	40	24	28	33	39
Very Hot (Approx. 100 °F)	22	24	30	35	14	16	19	22	31	34	39	44	27	32	37	44

* When run with PBJ wires.

TABLE B

Time for 20 complete swings. Seconds	Dip. Inches	Time for 20 complete swings. Seconds	Dip. Inches	Time for 20 complete swings. Seconds	Dip. Inches
13	5	23	16	33	33
14	6	24	17½	34	35
15	7	25	19	35	37
16	8	26	20½	36	40
17	9	27	22	37	42
18	10	28	24	38	45
19	11	29	25½	39	47
20	12	30	27	40	50
21	13	31	29	41	52
22	14½	32	31	45	62

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L.N.E.R. **E. 1003**

Chief Engineer's Dept.
Technical Instructions
Signalling and Communications

TRANSMISSION.
Overhead Lines
Relative Position of Wires on Telegraph Poles

1. The relative position of line wires on Telegraph Pole Lines should be as follows, commencing from the top arm or saddle position :—

1. Blocks and Bells
2. Telephones
3. Telegraphs, including Teleprinters
4. Signalling Indicators
5. Signalling Controls
6. Power Supply

2. The power supply wires should be located at the outside positions of a separate pole arm, of such length that the climbing space between the wires is not less than 3 ft. 6 in. The arm carrying the power wires should be fixed 2 ft. 0 in. from the arm above. If either of these requirements cannot be met, " DANGER " plates must be fitted.

3. In future works, the saddle position should not be used.

4. In planning circuit positions the following principals should be observed as far as is practicable :—

(i) Circuits should occupy uniform positions throughout their length.

(ii) The longest circuits should be on the uppermost arm of the group.

(iii) A circuit should be on the side of the pole from which it branches off.

5. Telegraph and Block Bell circuits should not occupy the same arm as Telephone circuits but, in other cases, subject to the relative positions being maintained, there is no objection to wires in different groups occupying the same arm.

Reference :— A.C.E. (S) Conference Minute No. 76/43.
Authorised by Chief Engineer 18-11-43.

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1001/2/46 100

L.N.E.R.

Chief Engineer's Dept.
Technical Instructions
Signalling and Communications

E. 1021

TRANSMISSION
Overhead Lines
Earth Wiring of Poles and Arms

GENERAL.

1. Poles should be fitted with earth wires, in the circumstances detailed below, and primarily for the purposes indicated :—

(*a*) To act as lightning conductors.

(i) On every 7th pole on main lines. (Preferably at transposition poles).

(ii) On all junction poles.

(iii) On all poles in exposed situations subject to lightning.

(*b*) To minimise the effect of leakage from telegraph circuits to other circuits.

On all poles carrying single wire telegraph circuits. (Single needle or teleprinter).

METHOD OF FITTING.

2. The earth wire must be run straight down on the side opposite to that on which the arms are fixed and clear of arm bolt washers.

3. It must project about 3 inches above the ridge of the pole roof and bend so as to clear the roof.

4. At the butt end of the pole about 3 feet of the earth wire must be formed into a flat spiral and secured by staples.

5. The wire to be used is 150-lb. H.D. Copper, serviceable second-hand wire if available.

6. The earth wire is to be stapled to the pole by 1 inch brass staples, spaced about 9 inches apart from the ground line to about 8 feet up the pole, and about 2 feet apart above that height.

7. H poles must have both sides earth wired.

POLES IN PROXIMITY TO H.T. OVERHEAD POWER LINES.

8. Earth wiring of poles near overhead power lines may involve risk of shock to men working on the poles. This risk can be minimised by terminating the earth wire at a point one foot above ground level. When the earth wire is so terminated, the lowest staple should be fitted not less than 3 inches from the end of the wire.

9. Instructions to modify the earthing, in the manner described above, will normally be received from the Area Office, where calculations have to be made to determine the various effects of power lines adjacent and/or parallel to the Company's lines. If such instructions are not received and there appears to be any possibility of a risk being incurred, the attention of the Area Office should be drawn to the case concerned.

EARTH WIRING OF ARMS.

10. Arms should be earth wired only when they carry single wire telegraph circuits or are likely to carry such circuits.

11. The wire to be used is 100 lb. H.D. Copper, serviceable second-hand if available, and fixed by ½ inch brass staples.

12. The wire must be passed round the arm between each pair of insulators, and along the face of the arm, as shown in Fig. 1.

13. The arm earth wire must be connected to the pole earth wire by a lead of 100 lb. copper wire, the joints at each end of the lead being wrapped with binding wire and soldered.

14. Contact between earth wires and metal fittings of the pole, *e.g.*, arm bolts, is undesirable and must be prevented by suitably bending the wire, sharp bends being avoided.

Reference :—A.C.E. (S) Conference Minutes No. 57/45.
Authorised by Chief Engineer 7-6-45.

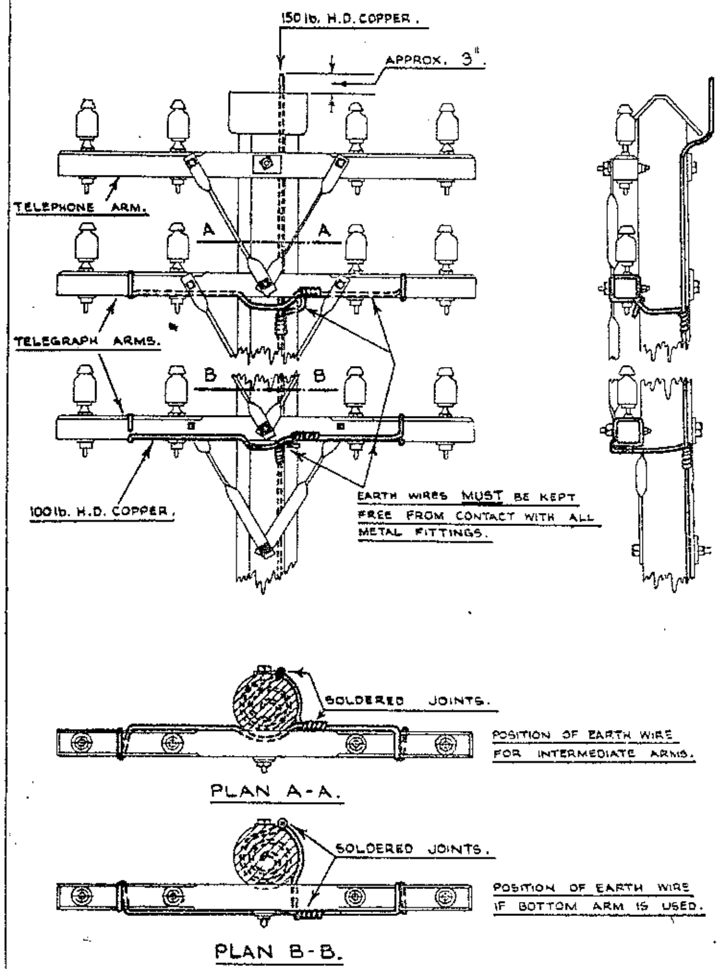

FIG. I.

L.N.E.R.
Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

E. 1101.
Transmission.
Pole Line.
Marking, Inspection and Testing.

GENERAL

1. It is important that telegraph poles should be regularly inspected and tested to ensure the timely replacement of defective poles.

2. To facilitate description and identification of such poles it is necessary that they should all bear reference numbers.

3. In order that the foregoing may become effective, the following instructions are to be carried out.

MARKING

4. All telegraph poles are to be numbered in sequence from the mile posts, *e.g.*, the sixteenth pole beyond the forty-second mile post will be numbered :—

④ ②
① ⑥

5. The year of planting of the pole, if known, is to be indicated by the last two digits of the year, *e.g.*, if the above pole had been planted in 1931, the numbering would be :—

④ ②
① ⑥
③ ①

6. All transposition poles should have the code letter above the other figures, *e.g.*, if the transposition letter were "C," the complete numbering for the above case would be :—

C

4 2

1 6

3 1

7. If there are two pole lines, one on either side of the line, then the Down side route should have a suffix "A" added, after the sequence number in each case, *e.g.*, if it were a pole on the Down side and there were also an Up side route, the complete numbering for the above case would be :—

C

4 2

1 6 A

3 1

8. The numbers are to be made up by means of number nails driven into the posts on the same side as the arms, the lowest number to be at a height of ten feet from the Butt. In exceptional cases of very tall poles this height may be increased to fifteen feet.

INSPECTION AND TESTING

9. All telegraph poles must be inspected annually. After having been planted for ten years, they must be exposed and probed to a depth of two feet below ground level and, thereafter, they must be examined in this manner at three-yearly intervals.

10. All poles showing evidence of decay, at any time, must be exposed and probed as above.

11. Inspections must be carried out by an Inspector, or other responsible member of the staff. Proper records should be kept so that, in any one year, it will be known which poles have to be exposed and probed on the three-yearly basis.

12. Any evidence of decay is to be reported to the Area Office quoting the pole reference number(s). Where necessary, immediate action must be taken to effect temporary repairs. Permanent renewal will be proposed, as heretofore, in the Annual Telegraph Renewal Programme.

Reference: A.C.E. (Signals) Conference Minute No. 85/44.

Authorised by Chief Engineer: 9.5.44

LNER 740/2/46 250

L.N.E.R.

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

E.1102.

TRANSMISSION.
Overhead Lines.
Pole Routes.
Inspection and Testing Methods and Safety Measures.

GENERAL

1. The purpose of this instruction is to describe the methods to be employed in testing Telegraph Poles, etc., during inspections. It also describes the safety measures to be taken before any work is commenced on a pole.

2. Poles must be examined and tested at the intervals laid down in instructions, in order that proper maintenance and renewal may be effected and the pole line kept in good repair.

3. It is extremely important that a pole should be safe before work is undertaken on it. Defective poles or fittings may be the cause of serious accidents.

INSPECTION

4. When an inspection is carried out at any time, examination should be made not only of the Poles but also of Arms, Spindles, Insulators, Steps, Stays, Stay Tighteners and Wires (including Earth Wires).

The places most liable to decay or corrosion are as follows :—

Part	Position	Tendency
Pole Base ..	Short distance above or below ground level	Decay
Pole Tops ..	Near Arm slots (if any)	Decay
Pole Arm ..	Between ends and insulator spindles	Shakes and Cracks
Pole Arm ..	Generally on curves	Warping and Twisting
Pole Steps ..	Round Coachscrews .. .. On steps	Decay Corrosion
Stay Wire ..	Loops round pole tops and make off to stayrod	Corrosion
Stay Tighteners	Screw Thread	Corrosion
Stay Rod ..	Near or at ground level	Corrosion
Line Wire ..	At Insulators	Chafing
Line Wire ..	General	Corrosion

TESTING METHOD

5. When examining Pole Routes it is desirable to carry an Inspection Hammer (*i.e.*, having a long shaft and spiked peen) together with a small auger (not larger than ⅜ in. diameter). A wire gauge is also useful if the Line Wires are being examined for renewal details, although an experienced eye can, by careful scrutiny, judge if a line wire is corroded sufficiently to warrant renewal.

6. When being inspected, poles must be sounded from ground level to as far as can be reached. If, when tapped with a hammer, the pole gives out a hollow and dead sound, then it will generally be found that there is internal decay at that place, however good the outside appearance may be. A good pole will give a distinctive ringing sound.

7. The auger will give a more thorough test and should be used in cases where it is necessary to confirm the hammer test. A test bore, slanting slightly upwards, should be made at the place indicated. This will reveal whether the pole has :—

(*a*) Rot, which can be detected by the wood borings being soft and powdery instead of hard and lacking in characteristic resinous smell.

(*b*) Hollow interior due to decay, indicated by the auger penetrating suddenly further into the pole.

If the test bore shows that the pole is sound, the hole should be plugged with a piece of wood, shaped to suit, in order to prevent incipient decay.

8. When it is suspected that the pole is decayed only at or near the surface, judicious use may be made of the spiked end of the inspection hammer. On no account should the spike be used to probe deeper than an inch or two. The Pole may be considerably weakened and premature decay result, with consequently early renewal, through indiscriminate and unnecessary use of the spike.

9. When the butt of a pole is exposed, as required by instructions for periodic inspection, the wood should be tested as described above.

10. When a pole is found to be defective it must be marked with a circular patch of white paint about 3 ins. in diameter, at a height of 4ft. above ground level and facing the Track.

SAFETY MEASURES

11. When line wires are being dismantled, cut, or recovered, from a pole which is stayed; steps must be taken to counteract the strain of the stay wires before the line wires are cut.

12. When telegraph poles are being taken down, they must be properly secured with ropes, or other means, before the stay wires are removed.

13. When renewing stay wires, the new ones must be fixed before the old ones are removed.

NOTE

14. Attention is drawn to Engineer's Department Additional Instructions Nos. 432, 436 and 438.

Reference: *A.C.E. (S) Conference Minute No.* 111/45.
Authorised by Chief Engineer. 30.11.45.

L.N.E.R. **E. 1103**

Chief Engineer's Dept.
Technical Instructions.
Signalling and Communications.

TRANSMISSION

Overhead Lines
Pole Routes
Marking for Proposed Renewal

GENERAL

1. In order to draw attention readily to Telegraph Poles requiring renewal, all such poles must be marked in accordance with the following instructions.

PROPOSED RENEWAL

2. All poles proposed for renewal must be marked before inspection, by painting a circular white patch about 3 inches in diameter on the side facing the Track at a height of four feet above ground level.

RENEWAL AGREED

3. After inspection, if the renewal of the pole is agreed, the white patch must be painted over with red so that the white is obliterated.

4. The red paint should be of a distinctive light shade so that it will be easily distinguished from the background colour (*e.g.*, vermillion).

RENEWAL NOT AGREED

5. If the renewal is not agreed, the white patch should be left on the pole in readiness for the following year's proposals. If necessary a re-touching of white paint should be applied immediately before further inspection.

Reference A.C.E. (S) Conference Minute No. 13/46.
Authorised by Chief Engineer 10-4-46.

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