Report of the Committee on a Recommended Standard Form of Table for Electric Lever Interlocking.

The following committee was appointed by Council Minute No. 4264 of December 8th, 1937, its terms of reference being to draw up a recommended standard form of table for electric lever interlocking and to report to the Council :-

F. HORLER ... Signal Engineer, Siemens & General Electric Railway Signal Co., Ltd., East Lane, Wembley, Middlesex (*Chairman*).

L. J. BOUCHER ... Office of Assistant Engineer (Signals and Telegraphs), Southern Railway, Wimbledon, London, S.W.19.

A. J. GOLDING ... Signal & Telegraph Engineer's Office, London, Midland and Scottish Railway, Euston House, London, N.W.1.

R. HODGES ... Signal Engineer's Office, Great Western Railway, 80, Caversham Road, Reading.

W. R. JONES ... 31, Crosby Road, Birkdale, Southport. (Retired Divisional Signal & Telegraph Engineer, London, Midland and Scottish Railway).

A. MOSS ... Signal & Telegraph Engineer (Scotland), London and North Eastern Railway, Leith Street, Edinburgh.

C. F. D. VENNING Westinghouse Brake & Signal Co., Ltd., 82, York Way, King's Cross, London, N.1.

J. WOODHOUSE General Railway Signal Co., Ltd., 528, Australia House, London, W.C.1.

M. G. TWEEDIE Signal Engineer's Office, Great Western Railway, 80, Caversham Road, Reading (*Honorary Secretary*).

REPORT.

To the President and Council of the
Institution of Railway Signal Engineers.

Gentlemen,

Your committee appointed on December 8th, 1937, have held seven meetings and, as a result of their deliberations and study of the subject, have reached the conclusions embodied in the following report :—

(1) Your committee recognised at the outset that, although the same understanding of the result to be obtained was necessary, different methods of approach were required in preparing tables for mechanical and electrical interlocking, due to the following contrasted characteristics :—

Mechanical Interlocking.	*Electrical Interlocking.*
A lever performs its function of locking other levers in the process of its operation.	A lever is locked until it is released by the supply of current to its lever lock.
Interlocking, including conditional interlocking between levers, is inherently reciprocal in character.	To interlock two levers two separate and complementary circuits are required. With conditional interlocking three or more circuits may be required.

(2) They were desirous of providing a form of interlocking table that would make the most direct and easy transition from the study of mechanical to electrical interlocking.

(3) They considered that such a table should be :—

- (*a*) Comprehensive.
- (*b*) Clear, concise and easily readable.
- (*c*) Free from ambiguity.
- (*d*) Simple to write out and with the fewest possible special characterisations.
- (*e*) A methodical aid to compilation.
- (*f*) Readily translatable into circuits.

(4) The table they now recommend consists of eight columns, numbered from left to right.

The first three columns are allocated as follows :—

(1) Lever number.

(2) Nomenclature.

(3) Locked in position.

Columns 4, 5, 6, 7 and 8 have a common heading, " released by," with the following sub-headings :—

(4) Unconditionally.

(5) Conditionally.

Columns 6, 7 and 8 have a common sub-heading, " converses," with the further sub-divisions :—

(6) Reverse.

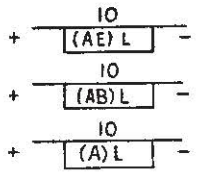
(7) Normal and reverse.

(8) Special.

(5) The following notes explain the intention with regard to the use of each column :—

Column 1.

The lever, the number of which is entered here, stands normally locked and is released by a circuit made through contacts on other levers, as entered in columns 4 to 8.

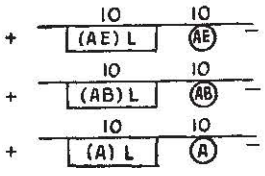


Column 2.

The use of this column is optional. It may be filled by the full description of the lever function, or used to indicate a signal route or designate the lever simply as operating points, signal, G.F. control, spare, etc.

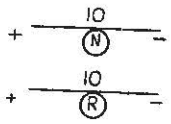
Column 3.

The usual interlocking positions are "A" for normal lock, " B " for signal back lock, and " E " for reverse lock.



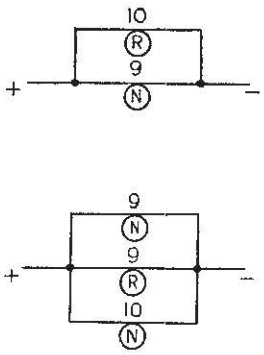
Column 4.

In this and succeeding columns it becomes necessary to express the fact, not of one lever locking another, as in mechanical interlocking, but of one lever in the normal and/or reverse position releasing another. A lever in the normal position is shown by a plain number as " 10." A lever in the reverse position is shown with the suffix " R " as " 10R."



Column 5.

All conditions are expressed by the use of the word " OR " between alternative releases, each complete alternative condition being enclosed in square brackets such as[9 or 10R], or if a both position release in round brackets as (9 or 9R). The brackets enclosing a both position release are retained when it forms part of a greater condition, in order to make the circuit requirements clear, as [(9 or 9R) or 10].



In the case of a signal lever the compilation will be greatly facilitated if the entries are made in the following order :—

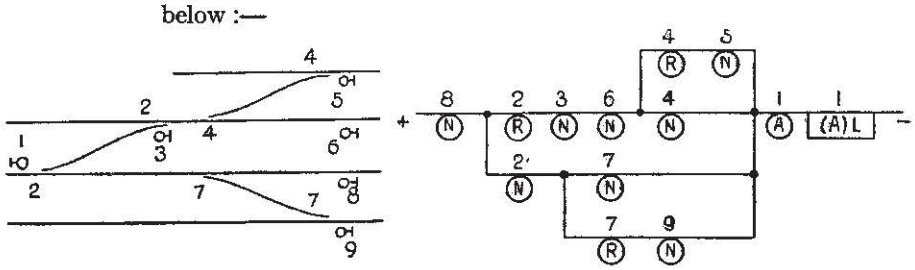
(*a*) Enter the both way release by the points immediately ahead enclosed in round brackets.

(*b*) Enter the conditional releases on the left hand route through those points, up to and including the both way release by the next facing points on that route, the whole being enclosed in square brackets.

(*c*) Complete the left hand route in this way and then follow with the second from the left, working through the whole routes from left to right.

(*d*) Continue with the routes in rear of the signal by a similar process.

The sequence of these entries is exemplified by the diagram below :—



1 is released unconditionally by 8 and conditionally by (2 or 2R) [3. 6. (4 or 4 R) or 2] [5 or 4 or 2] [(7 or 7R) or 2R] [9 or 7 or 2R].

Columns 6 *and* 7.

In these columns are entered the releases required to make effective the holding of a lever in the reverse position or in both normal and reverse positions.

Note.—The converse of a reverse release is a normal release. (See figure 2, Appendix 1.) The converse of a normal and reverse release is a normal release. (See figure 3, Appendix 1).

Column 8.

This is for the entry of conditional releases which are not direct reciprocals, but which are necessary to maintain the conditions whereby releases shown in column 5 are given. An example of this is given in Appendix II. Columns 6, 7 and 8 are required essentially for circuit drafting and cross-checking, and are not required for the ordinary reading of the table.

(6) When the converse of a release is obtained by indirect means, or when, to suit operating conditions, a converse is not required, this should be indicated by a short thick line under the release, as '10R.' Examples appear in Appendices I and II.

(7) The table appears in completed form in figure 1.

(*Signed on behalf of the committee*)

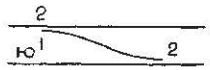
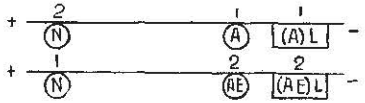
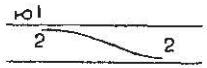
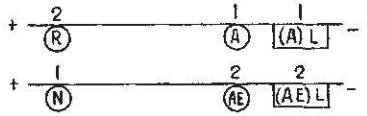
F. HOELER, *Chairman.*

M. G. TWEEDIE, *Honorary Secretary.*

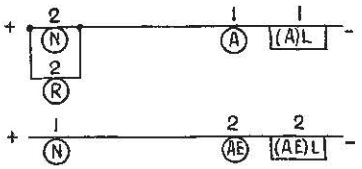
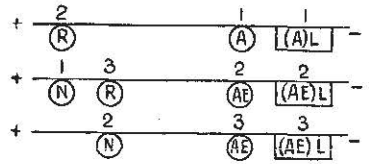
FIGURE I.

LEVER No.	NOMENCLATURE	LOCKED IN POSITION	RELEASED BY				
			UNCONDITIONALLY.	CONDITIONALLY.	CONVERSES		
					REVERSE	NORMAL AND REVERSE	SPECIAL
1	2	3	4	5	6	7	8

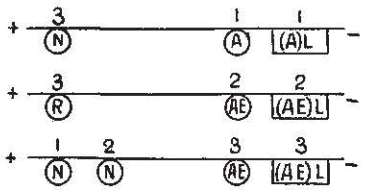
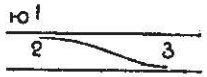
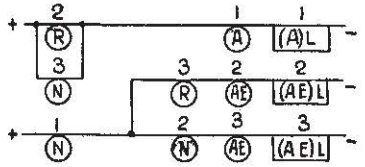
APPENDIX I.

	Interlocking.	Layout.	Circuit.
1	1 is released by 2. 2 is released by 1.		
2	1 is released by 2R. 1 must be replaced before 2 is replaced therefore. 2 is released by 1.		

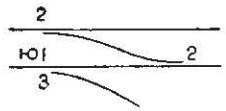
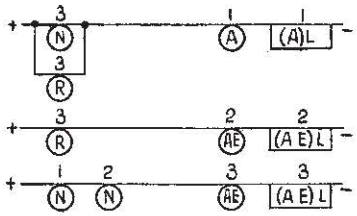
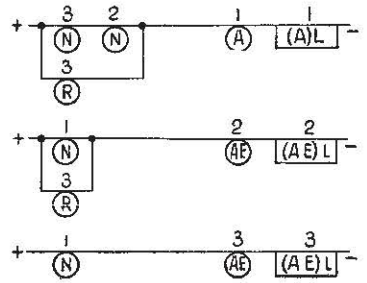
APPENDIX I (*contd.*)

	Interlocking.	Layout.	Circuit.
3	1 is released by (2 or 2R). 2 must not be moved with 1 reverse therefore. 2 is released by 1.		
4	1 is released by 2R. 2 is released by 1. 3R. 3 is released by 2.		

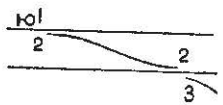
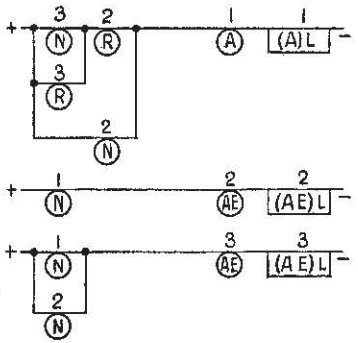
APPENDIX I (*contd.*)

	Interlocking.	Layout.	Circuit.
5	1 is released by 3. 2 is released by 3R. 3 is released by 1. 2.		
6	1 is released by [2R or 3] 2 is released by 1. 3R. 3 is released by 1. 2.		

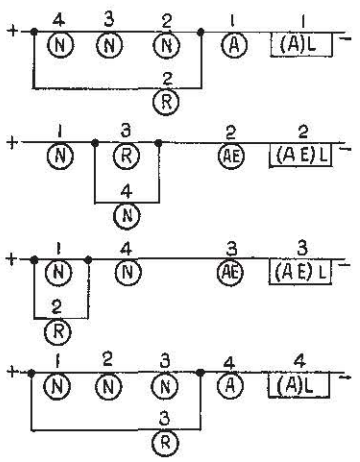
APPENDIX I (*contd.*)

	Interlocking.	Layout.	Circuit.
7	1 is released by (3 or 3R). 2 is released by 3R. 3 is released by 1. 2.		
8	1 is released by (3 or 3R) [2 or 3R]. 2 is released by [1 or 3R]. 3 is released by 1.		

APPENDIX I *(contd.)*

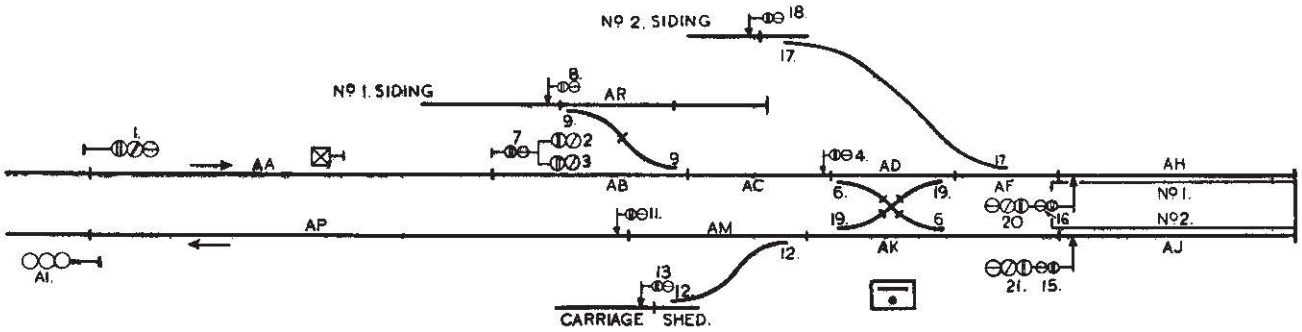
	Interlocking.	Layout.	Circuit.
9	1 is released by (2 or 2R) [(3 or 3R) or 2]. 2 is released by 1. 3 is released by [1 or 2].		

APPENDIX I (*contd.*)

	Interlocking.	Layout.	Circuit.
10	1 is released by (2 or 2R) [3. 4 or 2R]. 2 is released by 1. [4 or 3R]. 3 is released by 4. [1 or 2R]. 4 is released by (3 or 3R) [1. 2 or 3R]. *Note.*—The reciprocal releases between signals 1 and 4 are not conditional upon the same point setting, so that both points are forced to be reversed before the signals are free together.		

APPENDIX II, SHEET I.

LAYOUT.



SPARE LEVERS – 5, 10, 14, 22, 23.

TRACK & SIGNAL PLAN.

THIS DIAGRAM IS TO PROVIDE EXAMPLES OF INTERLOCKING & IS NOT TO BE TAKEN AS REPRESENTING SIGNALLING PRACTICE.

APPENDIX II, SHEET 2. Recommended standard form of table for electric lever interlocking

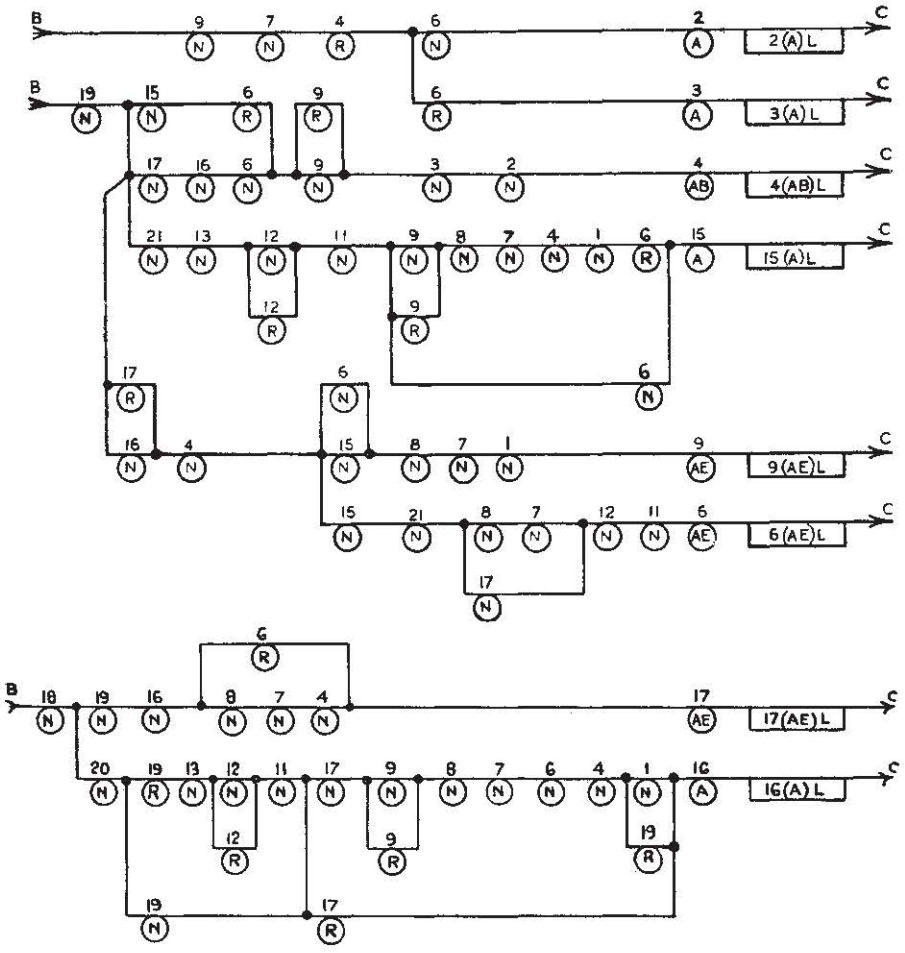
(1) LEVER No	(2) NOMENCLATURE	(3) LOCKED IN POS	RELEASED BY		CONVERSES.		
			(4) UNCONDITIONALLY	(5) CONDITIONALLY	(6) REVERSE	(7) NORMAL & REV.	(8) SPECIAL
1	SIGNAL	A	7.9.	[16 or 17R or 19R] [15 or 6]			
2	SIGNAL	A	4R. 6*2 7.9*2				
3	SIGNAL	A	4R. 6R*1 7.9.				
4	SIGNAL	AB	19.	(6 or 6R) [16. 17. or 6R] [15 or 6] (9 or 9R)	2.3.		
5	SPARE						
6	POINT	AE	11.12.19.21.	[16 or 17R]		4.15.	[17 or 7.8.]*3
7	SIGNAL	A	1.2.3.9.19.	[16. 17 or 6R] [15 or 6]			
8	SIGNAL	A	9R.	[16. 17. or 6R] [15 or 6]			
9	POINT	AE	1.7.19.		8.	4 [16 or 17R] [15 or 6]	
10	SPARE						
11	SIGNAL	A	6 12.15.20.21	(19 or 19R) [16 or 19]			
12	POINT	AE	6.11.20.21.		13	15 [16 or 19]	
13	SIGNAL	A	12R.15	(19 or 19R) [16 or 19]			
14	SPARE						
15	SIGNAL	A	11.13.19.21.	(6 or 6R)(12 or 12R) [(9 or 9R) 1.4.7. 8 or 6]			
16	SIGNAL	A	18.20.	(17 or 17R)(19 or 19R)[(12 or 12R) 11.13. or 19]			
				[(9 or 9R) 4.6.7.8. or 17R] [1 or 17R or 19R]			
17	POINT	AE	19.	[4.7.8 or 6R]	18.	16	
18	SIGNAL	A	16.17R.				
19	POINT	AE	4. 6. 7.9.15.17.21.		20	11.13.16.	
20	SIGNAL	A	11.12.16.19R.				
21	SIGNAL	A	6.11.12.15.19.				
22	SPARE						
23	SPARE						

*1—A converse of this release is unnecessary since 4 must be replaced before 6 can be returned to normal (as 6 is released by 4), and 3 must be normal before 4 can be returned.

*2—A converse of 2 released by 6 and 9 is unnecessary since both 6 and 9 require 4, whilst 2 is released by 4R.

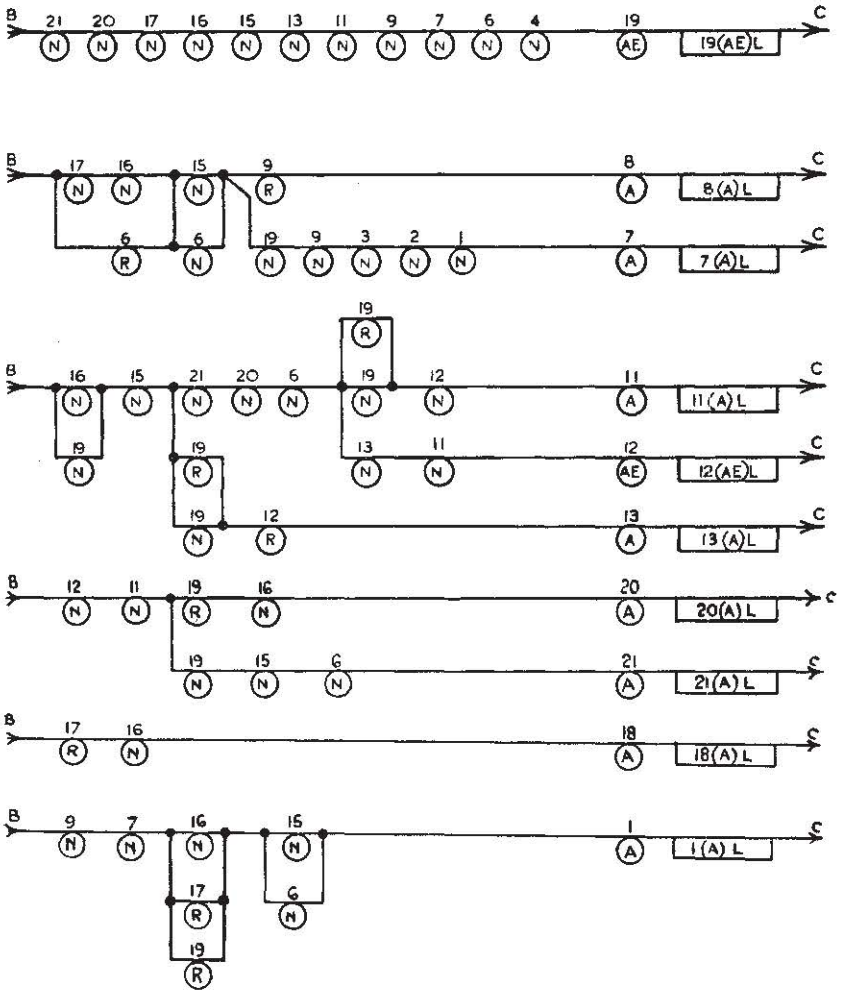
*3—7. 8 would, in common practice, be released by [6 or 6R] but to illustrate the use of the "special" column this has been omitted in this instance. Consequently [17 or 7. 8] has been included to hold 6 for the conditions—7 released by [17 or 6R]
8 " " [17 or 6R]
17 " " [7. 8 or 6R]

APPENDIX II,



SHEET 3.

Circuits



WRITTEN COMMENT.

Mr. F. J. Dutton thought the word " normal " on line No. 2, item 5, column 1, should be deleted, as the lever lock was not necessarily a normal one. This was shown by the example at the right hand side which showed both AE and AB type locks. He also suggested that columns 4 and 5 should be amalgamated and the square brackets dispensed with. This would simplify the table and render it free from ambiguity, as would be appreciated on comparing the locking at present shown therein against lever No. 4 with that proposed by him, as follows :—

As recommended by the report.

(1) Lever No.	(2) Nomen-clature.	(3) Locked in Pos.	Released by (4) Un-conditionally.	(5) Condition-ally.	Converses. (6) Reverse	(7) Normal & Reverse	(8) Special.
4	Signal	AB	19	(6 or 6R) [16.17. or 6R] [15 or 6] (9 or 9R)	2.3.		

As proposed by Mr. Dutton

(1) Lever No.	(2) Nomen-clature.	(3) Locked in Pos.	(4) Released by	Released by Converses. (5) Releases.	(6) Normal & Reverse.	(7) Special.
4	Signal	AB	(6N.17N.16N or 6R.15N) 19. (9N or R)	2.3.		

He agreed that any such table ought to be readily translatable into circuits and thought it would be found that his proposed modification was an improvement in this respect. For example, the table in the report showed two items for 6R although there was only one reverse contact in the circuit. Another argument in support of the proposed alteration was that column 7 included both conditional and unconditional controls but was not sub-divided. Conditional controls could be enclosed in the round brackets and the letters N and R used inside them, as required, it being assumed that all figures not enclosed by brackets referred to the normal

position. Mr. Dutton would also suggest that the word " reverse " be replaced by " releases " in column 6, because that column was used for the converse of releases and would then be in accordance with the standard mechanical locking table used by his company. When referring to the layout diagram in connection with column 8 it would be seen that 6 should be locked by 7 or 8, whereas it was obviously free when 17 was normal. It was noted that 7 and 8 locking 6 both ways had been deliberately omitted but its equivalent had not been substituted. Apparently this column would only be necessary for the converses of special locking having two normal conditions. An example of that could not, however, be cited from the layout in question. It was the practice on Mr. Dutton's division to mark superfluous locking by a small " s " above the figure and it appeared desirable to adopt this method in this new table. Presumably the use of the short thick line was optional.

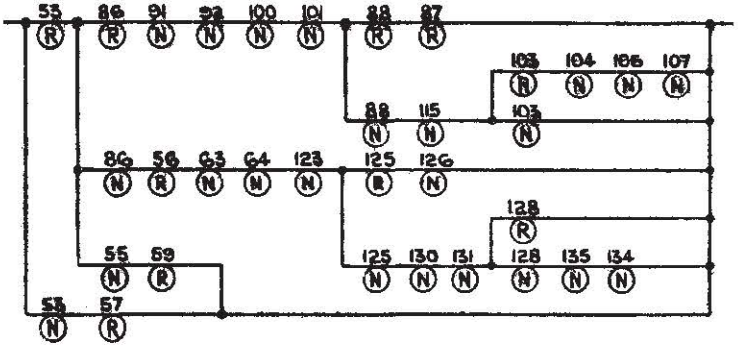
Mr. J. S. Moore based his comments on two assumptions ; (*a*) that direct mechanical interlocking was intended to be provided between point levers, and (*b*) that all other locks were released from the locked condition through lever and track circuits, their restoration to that condition being effected by gravity when the circuits concerned were broken. If this were correct then the title of the table should be " electro-mechanical interlocking table." The description of column No. 2 appeared to be somewhat ambiguous and he would be glad if its purport could be more specifically explained. The provision of a circuit column might perhaps be an improvement. The deliberations of the committee and the recommended table of interlocking which had resulted from them would, he felt sure, be greatly appreciated by all students of signalling and of its very important branch, the working out of interlocking and the means of accomplishing it.

Mr. C. Carslake congratulated the committee on the excellent character of the report. The locking representatives on his staff had carefully considered it and made a few suggestions, which he now offered as such and in no sense as a criticism of the work of the committee. The proposed table was similar to that used for mechanical locking but with separate columns for (1) bothways and special locking ; (2) releases ; (3) between stroke locking ; (4) special locking (3rd condition), because electric locking was not reciprocal. The reverse releases were shown as,

for example, 7R and normal releases as 7, without any letter. That might probably lead to mistakes arising from the inadvertent omission of the letter in cases where the lever was required reversed. It was therefore suggested that normal releases should be written 7N. There seemed no necessity to complicate the table by using both round and square brackets and it was suggested that round ones only should be used for conditional releases. A further simplification would be to combine columns 4 and 5. The use of the term " requires " over columns 4 to 8 would be an improvement on " released by."

Mr. F. Horler, chairman of the committee, in reply to the comments received on the report, said it must be appreciated that the recommended form of table was not the only one that would be of practical value. Installations had been carried out from tables of extremely divergent character. The members of the committee were widely representative and at the outset of the work contributed their individually developed ideas. Each conceded something in the discussions which followed. The terms used for the column headings were given close consideration. The use of the verb " to release," so long established in mechanical interlocking as meaning precedence in operation, created a special difficulty, since it there clashed with the sense in which they understood it in electrical interlocking. There was no adequate alternative. This was said with all deference to Mr. Carslake's comments, which suggested using the term " requires." The verb " to lock " was a term not strictly applicable to electric interlocking. Of two levers, of which only one could be reversed at one time, they spoke of one being released by the other in the normal position, but of two levers, one of which could be reversed only if the other was first reversed, they spoke of one being released by the other in the reversed position. There were other terms familiar to them in mechanical interlocking which were not adopted in electrical interlocking. " Bothway lock," for instance, was superseded by the specific " N " or " R." In conditional locking the expressions " when " and " unless " were abandoned, all conditions being stated as alternative releases, the word " or " being used exclusively to express one, which should be particularly appreciated by the circuit designer. Mr. F. J. Dutton had criticised the use of the word " normal " on line No. 2, item 5, column 1, but the word actually used was " normally " and was meant to refer to the manner,—as much as

to say " in the ordinary way "—rather than the position in which the locking was operative. In view of the construction that could be placed on it, however, no doubt the committee would not be averse to its deletion. Both Mr. Dutton and Mr. Carslake suggested the merging of columns 4 and 5, considering that to do so would simplify the table and render it free from ambiguity. It would be agreed that in the example given by Mr. Dutton there was a case where there was at least as much to be said for as against the arrangement. That, however, was because there was so little interlocking expressed in it. In a big layout, where the conditional locking was complicated and far reaching, there could be no doubt that the divisions advocated by the committee were simpler. The accompanying diagram was an actual circuit of alternative releases.



It would be an interesting recreation to set this down in tabular form in its briefest terms, that was to say without twice using any lever-number-position. It could be written down systematically and intelligibly in the way described by the committee, but that would not, it was admitted, be the most concise one. All the direct releases taken from column 4 would appear in the circuit at one end of the alternatives. Column 7 had not been sub-divided because the entries in it would be relatively small. It did not seem necessary to use the suffix " N " for normal releases, whether enclosed in brackets or not, and that opinion was based on practice. The committee had not recommended any means of marking superfluous interlocking in the table. When electrical interlocking became superfluous it was better to remove the wiring. The thick underline was not intended for indicating

superfluous locking. It was used to make a record in cases where reciprocal locking would not appear in the table, because it was indirectly obtained. In other words, it was to obviate the putting in of superfluous locking. Mr. J. S. Moore had unfortunately made two incorrect assumptions when writing his remarks. The table was for use where there was no mechanical locking between any of the levers and made no provision for track circuit locking. Column 2 was intended to supply space for reference to the function performed by a lever, something more than the numbered reference in column 1 and supplementing it. Mr. C. Carslake had suggested that all releases should have a suffix, " N " or " R " as the case might be. There was something idealistic about that. The committee had considered the point. It was certain, however, that the " N's " would largely preponderate and the omission of the " N " did not appear to have led to error when tried in practice. It was interesting to note that Mr. Dutton had made the same suggestion. The two kinds of bracket, square and round, were introduced with a clear purpose. A normal and reverse release was a key condition in circuiting and the round bracket was reserved for identifying it at a glance. Its value would be noticeable in the circuit example given to Mr. Dutton. To replace " released by," over columns 4 and 5, by " requires " was not a certain improvement. The reasons for employing " released by " were given in the report, (see the comparison between mechanical and electrical interlocking and also paragraph 5, column 1).