Method for Checking Mechanical Locking

Demonstration of System for Signal Department Draftsmen Comparitively Inexperienced in This Work

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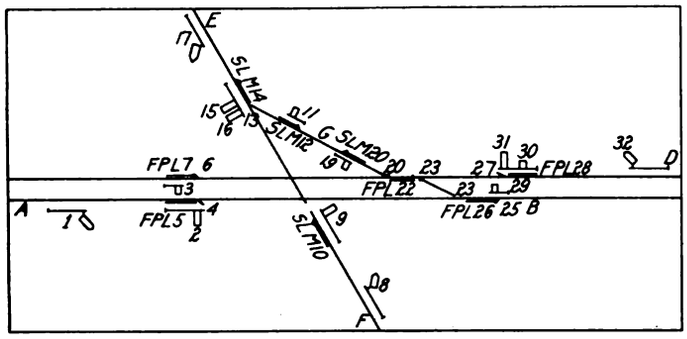
When there are a number of interlocking plants on a railroad system, the company's forces usually handle the engineering and labor connected with changes in track layouts, and it is generally necessary for the railroad's draftsman to prepare locking and dog charts to take care of the interlocking changes. Some roads have a man detailed exclusively to do this kind of work, but in most cases such a man, in addition to locking, must be able to handle circuit designing, estimating, etc. Since these



Track and Signal Layouts for Which Locking Is to Be Checked.

changes in interlocking come up infrequently, as compared with the other routine work, the locking becomes more or less neglected, and unless some system of checking is followed out in each case, the draftsman will consume more than double the time he should, not being positively sure as to accuracy in checking and possibly neglecting some of his other work, owing to the time taken for the locking.

With this condition in mind, a system has been developed, a part of which may seem very elementary, yet, in the absence of any instructions giving a better system, it is the only available course to follow. Using this system, the manipulation chart can be prepared, at the same time checking the proper routing as well as the proper sequence of levers.

The locking is made up in the regular way, derails locking trailing switches normal, facing point locks locking derails reverse, and switches normal and reverse, and signals locking facing point locks reverse. To illustrate, the accompanying sketch of a track layout is shown. From this plan the locking sheet has been made up. The system of checking shown below is built upon the same lines as the check which is given in the field after the machine is set up. To the expert in locking this check will seem superfluous, but to the man who is not an expert, it seems absolutely necessary. It is assumed that the reader has an elementary knowledge of locking sufficient to take care of conditions where the locking sheet is not made up correctly.

The track plan has been lettered up the same as for the ordinary manipulation chart. The lineup of all levers in the route wanted can be given, except the signals, and a check can then be made. Then the signals are pulled, locking up the route. A check should be made for the following:

(1) After all levers except the signal are reversed, the route must be lined up properly and the derails should be locked.
(2) After all levers are pulled but the signal levers reverse, the opposing derails conflicting with the route should be locked normal. All switches not in this lineup must be locked so movement cannot be made fouling the route set up. These in turn should lock the conflicting signals normal.
(3) After all levers, including signal levers are reversed, the route should be locked up so no switch or derail in the lineup can be put normal, and the signals governing same movement in the opposite direction must be locked normal.
(4) It should be possible to line up all routes not conflicting with the route given.
(5) Manipulation should be checked for proper sequence of levers.

To illustrate, take line-up A to B, referring to the checking outlined above:

(1) Reverse (25)-(26)-(4)-(5). (a) Functions which should be locked are (25)-(4)-23. (b) Referring to locking sheet, 26 locks (25), 5 locks (4), and 4 locks 23. Note that (a) and (b) check with each other. Function 23 here refers specifically to the switch in the route A to B. This is pointed out since there are two switches operated by this lever.
(2) Reverse (25)-(26)-(4)-(5). (a) Functions which should be locked are the opposing derails and switches, 10-14 W 13-23. (b) Referring to locking sheet, 4 locks 10-23 and 14 when 13 is normal locks (10). Since 10 is locked normal, 14 is locked normal, when 13 is normal. Note that (a) and (b) check with each other. Function 23 here refers to the switch not in the route set up.
(3) (a) Reverse (25)-(26)-(4)-(5)-(2)-(1). All functions in the route should be locked in their correct position after lever 1 is reversed. (b) From locking sheet, 26 locks (25), 2 locks (26), 5 locks (4), 2 locks (5), and 1 locks (2), while 2 locks opposing signal 29 normal. Note that (a) and (b) check with each other.
(4) Switches and derails which could be set up for movements not conflicting with this route are: (a) 27-20-6-12-14. (b) Referring to locking, no levers in the lineup lock any of these functions for routes not conflicting. Note (a) and (b) check with each other.
(5) Manipulation—(a) Levers should be pulled in the following order: 25-26-4-5-2-1. (b) 25 can be pulled reverse before 26-4-5-2-1, since it does not lock any of these functions. Similarly, 26 can be pulled before 4-5-2-1, 4 before 5-2-1, 5 before 2-1, and 2 before 1. Note that (a) and (b) should check with each other with the locking sheet.

If a mistake is made in the manipulation, it will readily show up. For example: Suppose the original manipulation had been made up 25-26-5-4-2-1. We will see that 25 can be reversed, as before noted. Also 26 can be reversed, but 5 cannot be pulled next because it locks 4 reversed, consequently 4 must be reversed before 5. As is well known, it is advisable to build up the manipulation first to require the towerman, pulling the levers, to exert the least amount of effort. This, of course, is taken care of partly in the locking, but there will be some variation in the possible manipulation of the levers. The best or ideal arrangement would be for the towerman to start at one end of the machine, working his way to the right or left, but always in the same direction, the last lever pulled being farthest away from the

Lever	When	Locks	Lever	When	Locks
1		(2)	17		(16)
2		(5)-(26)-29	18		Spare
3		(7)-(22)-30-31	19		(20)-(22)-30
	23	(28)		23	(28)
	(23)	(26)-29		(23)	(26)-29
4		23-10	20		--
5		(4)	21		Spare
6		20-10	22		20-(20)-23-(23)
7		(6)	23		--
8		(9)	24		Spare
9		(10)-16-(14)	25		--
10		13	26		(25)-23-(23)
	20	25-27	27		23
	23	25	28		(27)
11		(12)-(14)-15	29		(26)
12		(13)		23	(5)
13		--		(23)	(22)
14	13	(10)		(23)-20	(7)
15		(12)-(14)	30		(22)-(28)
	(20)	30		20	(7)
	(20)-(23)	29	31		(7)-(22)-(28)-30
16		13-(14)	32		(31)

Locking Sheet for Plan Shown Above.

first. It is not possible to arrive at this condition for every route, but the lineup should be made along these lines as nearly in consecutive order as possible.

With this explanation we now can come to the short-cut.

A to B—(1) (25) (26) (4) (5).
(a) (25)] (4)] 23]
(b) (25)] (4)] 23]
(2) (25) (26) (4) (5).
(a) 10] 23] 14 W 13.]
(b) 10] 23] 14 W 13.]
(3) (a) (25)] (26)] (4)] (5)] (2)] -(1).
(b) (25)] (26)] (4)] (5)] (2)] -29.
(4) 27-20-6-12-14 in conflicting routes O. K.
(5) 25 (26-4-5-2-1) 26 (4-5-2-1) 4 (5-2-1) 5 (2-1) 2 (1).

C to D—(1) (27) (28) (22) (6) (7).
(a) (27)] 23] 20] (6).]
(b) (27)] 23] 20] (6).]
(2) (27) (28) (22) (6) (7).
(a) 14 W 13] -10] -23] -20.]
(b) 14 W 13] -10] -23] -20.]
(3) (a) (27)] (28)] (22)] (6)] (7)] (3).
(b) (27)] (28)] (22)] (6)] (7)] -30-31.
(4) G to E, E to G, A to B, B to A, moves can be made.
(5) 27 (28-22-6-7-3)-28 (22-6-7-3)-22 (6-7-3)-6 (7-3) 7 (3).

E to F—(1) (10)-(14).
(a) 13] -(10).] Note 14 is S.L.M. locked by signal.
(b) 13] -(10).]
(2) (10)-(14).
(a) 12] -25 W 20] -27 W 20] -25 W 23] -6] -4.]
(b) 12] -25 W 20] -27 W 20] -25 W 23] -6] -4.]
(3) (a) (10)] -(14)] -(16)] -(17).
(b) (10)] -(14)] -(16)] -9.
(4) G to B, B to G, G to D, D to G, moves can be made.
(5) 10 (14-16-17)-14 (16-17)-16 (17).

E to G—(1) (13)-(12)-(14).
(a) (13)] 12 and 14 are S.L.M.'s locked by signal
(b) (13)]
(2) (13)-(12)-(14).
(a) 10.]
(b) 10.]
(3) (a) (13)] -(12)] -(14)] (15)
(b) (13)] -(12)] -(14)] 11 when (20) locks 30, when (20) and (23) locks 29.
(4) A to B, B to A, G to D, G to B, C to D, D to C, moves can be made.
(5) 13-(12-14-15)-12 (14-15)-14 (15).

G to D—(1) (27)-(28)-(20)-(22).
(a) 23] (27)] -(20).]
(b) 23] (27)] -(20).]
(2) (27)-(28)-(20)-(22).
(a) 23] 6.]
(b) 23] 6.]
(3) (a) (27)] -(28)] (20)] -(22)] -(19).
(b) (27)] -(28)] (20)] -(22)] -30.
(4) A to B, B to A, E to F, F to E, E to G, G to E moves can be made.
(5) 27 (28-20-22-19)-28 (20-22-19)-20 (22-19)-22 (19).

G to B—(1) (25)-(23)-(26)-(20)-(22).
(a) (25)] -(23)] -(20).]
(b) (25)] -(23)] -(20).]
(2) (25) (23) (26) (20) (22).
(a) 6] -4] -27.]
(b) 6] -4] -27.]
(3) (a) (25)] -(23) [-(26)] -(20)] -(22)] -(19).
(b) (25)] (23) [-(26)] -(20)] -(22)] -29.
(4) E to G, E to F, F to E, G to E, moves can be made.
(5) 25 (23-26-20-22-19)-23 (26-20-22-19)-26 (20-22-19) 20 (22-19)-22 (19).

D to C—(1) and (2) same as C to D.
(3) (a) (6)] -(7)] (22)] (27)] (28)] (31)] (32).
(b) (6)] -(7)] (22)] (27)] (28)] (31)] -3-30.
(4) Same as C to D.
(5) 6 (7-22-27-28-31-32)-7 (22-27-28-31-32)-22 (27-28-31-32) 27 (28-31-32)-28 (31-32)-31 (32).

B to A—(1) and (2) same as A to B.
(3) (a) (4)] (5)] (25)] (26)] (29).
(b) (4)] (5)] (25)] (26)] -2.
(4) Same as A to B.
(5) 4 (5-25-26-29)-5 (25-26-29)-25 (26-29)-26 (29).

F to E—(1) and (2) same as E to F.
(3) (a) (10)] (14)] (9)] (8).
(b) (10)] (14)] (9)] -16.
(4) Same as E to F.
(5) 10 (14-9-8)-14 (9-8)-9 (8).

G to E—(1) and (2) same as E to G.
(3) (a) (13)] (14)] (12)] -(11).
(b) (13)] (14)] (12)] -15.
(4) Same as E to G.
(5) 13 (14-12-11)-14 (12-11)-12 (11).

D to G—(1) and (2) same as G to D.
(3) (a) (20)] -(22)] (27)] (28)] (30).
(b) (20)] -(22)] (27)] (28)] -19-31-15.
(4) Same as G to D.
(5) 20 (22-27-28-30)-22 (27-28-30)-27 (28-30)-28 (30).

B to G—(1) and (2) same as G to B.
(3) (a) -(20)] (23)] -(22)] -(25)] (26)] -(29).
(b) -(20)] (23)] -(22)] -(25)] (26)] -19-15.
(4) Same as G to B.
(5) 20 (23-22-25-26-29)-23 (22-25-26-29)-22 (25-26-29) 25 (26-29)-26 (29).

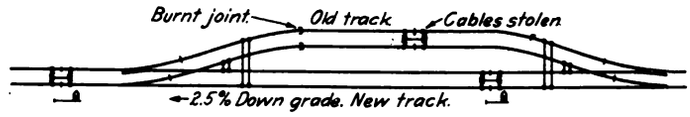
There are a number of ways in which short-cuts can be used, but this seems to give a start in the right direction. It is hoped that some of the more efficient locking men will give some of their views as to the best way to be positively certain that the locking is correct.

OVERCOMING A HAZARD IN A. C. TRACK CIRCUITS

By W. D. Cleveland

The theft of copper cables at impedance bonds in two-rail a. c. track circuits on electric roads creates a dangerous condition which is probably little realized on steam roads, even where alternating current has been adopted. As a result of the discovery of such a condition on an interurban railroad in the Northwest a few years ago an improved method of protecting these copper cables was tried, and for more than two years has proved satisfactory. The manner in which the accident referred to was caused, the results which followed, and the possibilities which were created emphasize the necessity for some measures to avoid similar trouble in the future.

The original signal installation on the road referred to was made on eight miles of line in 1911-12, the control circuit being a slight modification of the absolute-permissive-block system of the General Railway Signal Company for steam roads. Signals of the three-position upper left-hand quadrant semaphore type were installed. During the following year the traffic became so dense on this line that it was decided to double track this section and change over the signals for the protection of the new double-track line. During this reconstruction the signals were



Sketch of Track Connections Showing Location of Bonds.

kept working as much as practicable, for the protection was even more needed then on account of the many work trains and the speed at which this track work was pushed. At no time were more than four signals out of service. As fast as a piece of track was completed the signals were changed so that they would give protection in one direction only, although the track was often used for traffic in both directions. In many cases the impedance bonds were left connected to the old rails until needed, thus saving the expense of removing and storing them, for very often they did not have to be moved more than 200 ft. to the new location.

In the original installation the signal company had experienced some trouble with copper cable terminal wires to the impedance bonds being cut off and stolen, and the railroad company therefore instructed the signal company to use a galvanized pipe to protect the wires. This pipe was cut to the desired length for each installation, the cable for connecting to each rail being placed in a separate pipe and the two cables carrying propulsion current between the bonds on the opposite sides of the joints in one pipe. In some instances this pipe was 15 ft. long as the rails were not cut to bring the insulated joints opposite each other. These pipes were fastened to the ties with pipe straps made of 1 in. by ¼ in. strap iron, and two ½ in. by 4 in. lag screws were used to hold them down. In several instances after this, these pieces of pipe were torn up and the copper taken, but examination indicated that something dragging from a passing freight train had caught them and torn them up and the cables looked as though they had been pulled in two.

On the day of the accident referred to above, the signals on the new track had given warning of a very heavy slide which necessitated routing all trains over the old track, a connection being made at each end of the section affected. At one end, two insulated joints were put in the main track rails on the old track in addition to the one in the crossover rail, the new joints being located about 100 ft. from the switch point in order to carry the track circuits far enough to insure protection by the signal located beyond the switch. The insulated joints were left in at the impedance bond located on the old track in the section to be used for detouring trains and at the other end of the section one of the rails was cut in to form a return for the propulsion current.