With regard to the question of the proper colors to use for the night indications. As stated above practice has differed in this respect. Some roads use white for the clear indication (white in this case meaning that the lamp flame is not covered by any colored glass), and green for the caution indication of the distant signal. On the other hand, some roads use green for the clear or proceed indication, and orange for the caution. If we bear in mind again the principle of construction, it is not difficult to arrive at the conclusion that all night indications should be given by some distinctive color, and in no case should the flame itself be used, except as a stop indication. For if the white indication is used, a broken colored glass would give this indication. Up to the present the only colors with sufficient range to be used as night indications are the red, green and orange.

Another essential point to be remembered in connection with signaling is that it must be made impossible for any of the indications except the stop indication, to be displayed except by an authorized means. That is if the signal is operated by means of levers, then by means of the lever only, can any indication be made. This necessitates the use of a rigid connection between lever and signal, or if wire is used there must be a back and front wire, if only a single wire is used to pull the signal clear, any unauthorized person could clear the signal which is manifestly an unsafe condition.

The Standard Code definition of Interlocking is as follows: "An arrangement of switch, lock and signal appliances so interconnected that their movements must succeed each other in a predetermined order." Interlocking in Canada up to the present has been confined, to a great extent, to the protection of the crossings of two railways at grade. This is by no means its only possible application, and indeed is probably the least important of its uses. It finds its greatest economy in terminals, junctions, and at points where a great many switches are grouped together, at such points all the switches can be handled from a central point by one or two towermen, with absolute safety to the trains, and with the greatest amount of expedition.

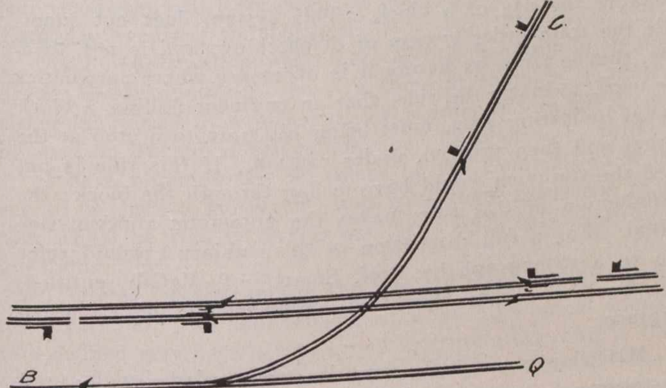

Fig. 2.

Under the law in Canada, all trains approaching a grade crossing with another railway, are required to come to a stop before proceeding over the crossing, unless the crossing is protected by interlocking. Aside from the safety afforded by interlocking the crossing, it can be shown that there is an actual saving in operating expense when the trains reach a certain number. Henderson in his "Cost of Locomotive Operation" estimates that it cost in the neighborhood of 65 cents to stop a train and again accelerate it to its original speed. Mr. Peabody, signal engineer of the Chicago & Northwestern R.R., after having experimented with different trains, concluded that it averaged 45 cents per train. For the sake of illustration, if we take 45 cents as the cost, it is an easy matter to determine how many trains per day will justify the expenditure necessary to install interlocking at a crossing. Fig. 1 shows in diagram the signaling necessary to protect a single track crossing a single track. There would be 16 levers, this sized plant installed would cost $4,800.00 and would require a day and night towerman to operate it. The yearly cost for the plant would stand about as follows:

Cost of interlocking, complete	$4,800
Interest on cost, 4%	192
Depreciation, 7%	336
Cost of maintenance per year	240
Cost of operation per year	1,200
Total cost per year	$1,968

Saving to be effected:

Trains per day.	Cost per year acct. stopping.	Total yearly cost of interlocking.	Net saving per year.	Cost of interlocking.	Time required to pay for installation from saving.
14	1,971	1,968	3	4,800	
20	2,817	1,968	849	4,800	5½ years.
25	3,521	1,968	1,553	4,800	3 "

It is apparent then that 14 trains a day over this plant would justify its installation, aside altogether from the saving due to increased safety.

Interlocking is based on the following principles: First. That a failure in any part of the apparatus will prevent a clear signal being displayed. Second. That the normal position of all signals is "stop." Third. That a signal cannot be cleared for a train to move across the interlocking until all the switches in the route are properly set and locked. Fourth. That a signal cleared locks all the switches, and that no switch or lock can be moved while the signal is clear. Fifth. That the signal cleared guarantees to the engineman the route, with no possibility of a move being made by any other train that could in any way foul the route given. In Canada the first four of these have been always conformed to, but the fifth (fully as essential as the other four) has not, Fig. 2 is a sketch of a plant in operation which does not. A train moving from B to C having received a clear signal, No. 1 is not protected from a possible movement by a train from Q which could cause a serious side swipe at the frog A. I have seen several other plants, which also have this serious loophole, and it has been my experience that if a loophole is left in any signaling installation it is only a question of time when some train will run into it.

In order to prevent a train running by a signal at a crossing, the law requires the use of a derailing switch operating in connection with the signals, the signal can only be cleared after the derailing switch has been closed and locked. The closing of the derailing switch on one line locks the derails on the crossing line open, the idea being that if signals alone were used, it would be possible to have a train on the crossing run into by a train on the other line should the engineer disobey the signal. Each individual interlocking plant is a problem in itself, different conditions either in track lay-out or operation, require different treatment in the location of the signals, and this is the province of the signal engineer. The signal engineer of a large road is one of the most important officials, his knowledge and experience must be large and varied, he should be a civil engineer, and also thoroughly understand how the trains are operated, his duties once the plant is installed, is closer allied to the operating end of the railway than to the engineering. In order for him to be able to advise what arrange-