The Highway-Crossing Signal Circuit Problem

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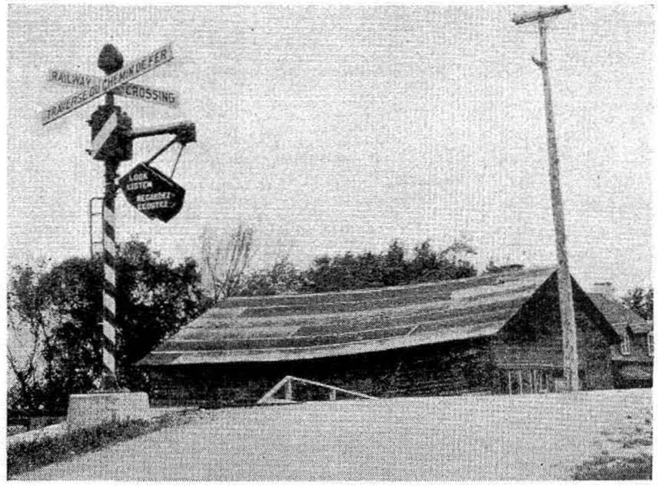

Wigwag signal at a crossing in Quebec

ON account of the enormous increase in automobile traffic in recent years and a corresponding increase in the number of busy highways, the problem of providing adequate highway-crossing protection at grade crossings has become an important one. Each year large numbers of wigwags, flashing lights, and other protective devices are installed by the railways. In many cases the existence of switching moves over or near a crossing and the widely varying speed of trains at such points, have considerable bearing upon the design of control circuits for these devices.

Excessive operation of a wigwag, flashing-light signal, or a similar device, which thus gives a warning to traffic either when no train is using the crossing or long before a train arrives, soon lessens the value of the warning. People using the crossing daily tend to disregard the signal which may often have kept them waiting unnecessarily, and tourists, after waiting a reasonable time, may decide that the mechanism is out of order, and drive over the crossing without first making certain that no train is approaching. In this way, many such crossing protection installations may become an actual hazard.

In order to avoid this condition, and at the same time to provide a nearly uniform warning of no less than 20 seconds, special circuits must be designed to meet each case. Several of these which are in actual operation are described here. A study of their operation may result in ideas for the solution of some other similar circuit problems.

The circuit shown in Fig. 1 is used to give speed-selective wigwag operation at a double-track crossing.

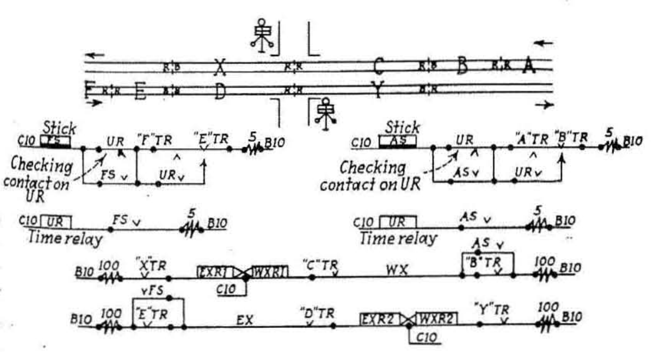

Fig. 1. Speed-selective wigwag circuit

Any desired speed may be chosen, above which the wigwag will operate from *two* track circuits approaching the crossing, and below which it will operate from only the one track circuit adjacent to the crossing. In the installation for which this circuit was designed, critical speed was taken as 60 m.p.h. Track circuits *C* and *D* were therefore made 2,000 ft. long, in order to provide a minimum of 20 seconds ringing for all speeds of 60 m.p.h. or less. Track circuits *B* and *E* were made 1,000 ft. long, which, when combined with *C* or *D*, would give a ringing section of 3,000 ft. for trains traveling more than 60 m.p.h. Track circuits *A* and *F* were not restricted to any particular length, these circuits extending back to the next cut-section or signal location. The timing relay used was a Union Model-DT-10 time-element relay. The stick relays were the slow-release type.

The operation of the circuit for an approaching train is as follows: As the train approaches the crossing, it shunts out track circuit *A*. With the back contact of this track relay closed, the checking contact of the *A* timing-relay closed (showing that this relay has been restored to normal position after its last operation and that its timing is therefore correct), and the *B* track relay energized, the *A* stick relay will be energized. The time-element relay is energized and starts its operation when this stick relay picks up. The stick relay will hold up through its own front contact when the checking contact on the timing relay opens as the latter relay operates. When the train has passed through *A* track circuit, track circuit *B* is shunted. The de-energization of *B* track relay opens the *A* stick circuit, but closing the back contact of the *B* track relay provides another source of battery for stick relay *A* if the timing relay has had sufficient time in which to complete its operation. The stick relay will then remain energized while the train is on the *B* track circuit. Thus, a by-pass is provided around the contact of the *B* track relay in the wigwag operating circuit. Then, a train traveling at a speed of less than 60 m.p.h. will allow the timing relay to complete its operation and will have a ringing circuit of only track circuit *C*. A train traveling at more than 60 m.p.h. will have a ringing circuit of track circuits *B* and *C*, since the timing relay cannot complete its operation.

The checking contact on the timing relay is necessary in this circuit in order to insure that this relay is restored to normal operating position after each operation. If this relay should return only part way to its normal position there would exist the dangerous possibility of its contact closing too quickly on the next operation, thus giving only 2,000 ft. ringing for a high-speed train. By means of this checking contact, however, the maximum ringing circuit is provided for *all* trains even if this relay has failed to return to its normal position.

The stick relays are of the slow-acting type, so that the time interval between the opening of the front contact and the closing of the back contact of the *B* track relay in the stick circuit, will be bridged.

Elimination of Excessive Wigwag Operation

There is a very interesting case of a wigwag which has to operate with almost human intelligence in order to give proper warnings. Scheduled train movements, as well as switching movements, were of such a nature that specially designed circuits were necessary, in order to avoid excessive wigwag operation. The track layout at this installation is shown in Fig. 2.

A westbound way-freight would sometimes cut its train just east of switch *K* in the wigwag operating circuit and go into the siding at *K*, to work. After completing its work there, the way-freight would sometimes stop at the freight shed just east of the station, thus causing still longer wigwag operation. By instructions to the crew to take the whole train into the siding whenever possible, part of the excessive operation of the wigwag was avoided. However, the original move occurred ocasionally, so that it was considered advisable to provide for it in the design of circuits. The stop at the freight shed could not be avoided, of course, and had to be considered.

This point is the western terminus of a local passenger service. The last night local arrived here about midnight. It pulled into the station but not over the crossing, unloaded its passengers, and backed out of the station to turn on the wye east of there. In turning at this point the local backed in over switch *K* and pulled out again on the main line by the east leg of the wye. It then backed west on the main line to a point just past switch *J*. Here the local occupied the crossing. After pulling into the siding over switch *J*, this train is held there for the early morning service. It was impossible for this local to enter the siding from the east end, thus eliminating the operation of the wigwag for the westbound back-up move on the main line, as there was already another train stored at the east end of the siding.

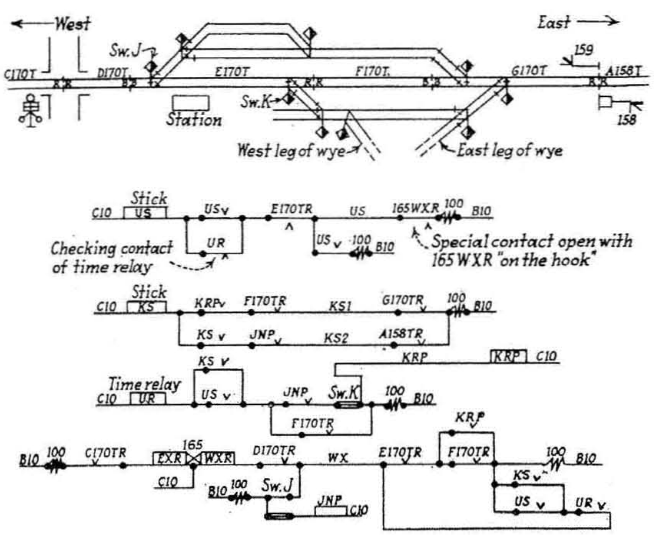

Fig. 2. These circuits were designed to eliminate unnecessary wigwag operation

Three trains in all were stored in these sidings during the night, to handle local business in the morning.

The first local started its morning service from this point about 6:00 a. m. It backed out on the main line over switch *J* about 5:30 a. m. and pulled up to the station. This move caused the wigwag to operate continuously from the moment the local backed onto the main line until it had cleared the westward wigwag ringing circuit, after loading passengers at the station and starting east on its run. Similar excessive operation occurred as the other locals left the siding.

A westbound train, which took the siding south of the main line for a meet with an eastbound train and pulled out of the siding over switch *K* after the latter train had passed and before it had cleared the westward wigwag operation circuit, would hold the interlocking relay "on the hook," thus being able to approach the crossing with the wigwag inoperative.

A similar condition existed for a move in which a westbound train came onto the operating circuit after an eastbound train, and waited on the main line just east of switch *K* for the eastbound train to take the siding.

With such train-operating conditions to overcome, the circuits shown in Fig. 2 were designed. These circuits may best be described by considering the manner in which they have accounted for the above operating conditions.

First, way-freight crews were instructed that, if their train was cut on the main line and a portion was left on track circuit *F170*, switch *K* must be left in the reverse position while switching. By tracing the front contact of track relay *F170*, which was used in the wigwag operating circuit with a front contact of the reverse repeater relay for switch *K (KRP)*, *F170* track circuit was cut out of the operating circuit of the wigwag when switch *K* was reversed. Thus unnecessary wigwag operation caused by the portion of the train left on the main line during switching, was eliminated.

Excessive wigwag operation caused by the presence of the way-freight on track circuit *E170*, during its stop at the freight shed, was prevented by the operation of a timing relay. The operation of the timing relay begins when a westbound train shunts track relay *E170*. Dropping this relay energizes the *US* relay if the timing relay *(UR)* has completely restored itself to full normal position following its last operation. The special contact of the *WXR*, or west side of the interlocking relay, is closed for all westbound train movements. By the use of this contact in the *US* relay circuit, this relay, and therefore the timing relay also, will operate *only* for westbound train movements. The *US* relay will stick up through its own front contacts, one of which shunts the checking contact of the *UR* relay, which opens as soon as that relay starts to operate. The other, the back contact of the *WXR* relay, opens when track circuit *E170* has been occupied long enough for the timing relay to complete its operation and permit the interlocking relay to pick up. The latter relay is energized through a bypass around front contacts of track relays *E170* and *F170*, provided by front contacts of the *UR* and *US* relays. The timing relay *(UR)* is energized through front contacts of the *US* or *KS* relays, through a front contact of the *F170* track relay or a front contact of the normal switch repeater relay for switch *J (JNP)* and a normally closed contact of the switch controller on switch *K*. The timing of the *UR* time-element relay is adjusted so that the relay will complete its operation only after sufficient time has elapsed for a through train, of average speed or better, to have reached the crossing. The wigwag always operates from track circuit *D170*, which is adjacent to the crossing and toward the east.

By the operation of the timing relay, unnecessary wigwag operation is avoided when the last local passenger train arrives. While this train remains on track circuit *E170* after the operation of the timing relay, the wigwag does not give further warning. While the train was backing into the wye and turning around, it was considered advisable to keep the timing relay energized to prevent additional wigwag operation when this train backed down the main line to take the siding at switch *J*. As the train approached the crossing slowly, prepared to stop just west of switch *J*, operation of the wigwag for track circuit *D170* was considered sufficient. In order to maintain the *UR*, or timing, relay energized, the *KS* relay was used. This relay is energized by the reversal of switch *K*, which causes the reverse repeater *(KRP)* relay for this switch to be energized. With a front contact of this relay closed, as well as similar contacts of track relays, *F170* and *G170*, the *KS* relay is energized. Use of the track-relay contacts in this circuit prevent the operation of the *KS* relay if the main line is occupied between switch *K* and signal *159*. Once energized, the *KS* relay sticks up as long as switch *J* remains normal and track circuit *A158*, in the rear of signal *159*, is unoccupied. If a through westbound train movement should occur while a train is turning on the wye, the shunting of track circuit *A158* will drop relay *KS* so that the wigwag will operate for the westbound movement. When switch *J* is reversed for the local to take the siding, all relays are restored to normal position.

The operation of the timing relay takes care of the situation created by the morning local train as it comes out of the siding and waits at the station.

An eastbound train on track circuit *F170*, having just passed switch *K*, still holds the west side of the interlocking relay *(165WXR)* "on the hook." In order to energize this side of the relay at this time, so that it will be ready to operate the wigwag for a westbound movement from the siding, the front contact of track relay *F170* in the interlocking relay circuit is by-passed by a front contact of the reverse-repeating relay for switch *K*. When this switch is reversed for a train to leave the siding, relay *KRP* picks up to close the by-pass. The interlocking relay is then shunted by the train leaving the siding and the proper wigwag operation is secured. The circuit operates in a similar manner when the westbound train occupies the main line and the eastbound train takes the siding.

In the event of a westbound train having operated the timing relay and then started to pull into the clear at switch *J* or *K* for a following train, the timing relay must be restored to its normal position, so that proper warning will be given for the following train. To accomplish this, a front contact of track relay *F170* was connected in multiple with that part of the *UR* circuit having a front contact of the normal-switch-repeater relay for switch *J (JNP)* and a normal switch box contact of switch *K* in series. Thus, with the following train on the *F170* track circuit, while either switch *J* or *K* is reversed for the first train to clear, relay *UR* will be de-energized. If, however, the following train had already passed completely over track circuit *F170* and was then occupying the track circuit *E170*, it was decided that this train would be so close to the crossing that the warning given by the track circuit *D170* was sufficient.

Battery was placed on the *165 WXR* circuit with switch *J* reversed, so that this relay would not be "on the hook" for a westbound movement from the siding at switch *J* immediately following an eastbound movement on the main line.

Pennsylvania Commission Report of Highway Crossing Accidents

THE Public Service Commission of Pennsylvania has issued its annual report on grade crossing accidents of steam railroads on the highways of that state. During 1933, a total of 568 accidents occurred, including all kinds of crossings, which is a 5 per cent reduction over that of 1932. Of these, 152 were on state highway crossings, and 311 were on unprotected street and road crossings. The accidents occurring during daylight and darkness were almost equally divided. Of the total of 12,134 public grade crossings in Pennsylvania, 18.5 per cent are protected by gates, watchmen, or some form of warning device.

On main-track grade crossings in 474 accidents, 74 motorists were killed and 273 injured, which amounts to a decrease of 7.75 per cent over the previous year. In the 168 accidents at protected street crossings, 23 were killed and 85 were injured. At state highway crossings, 17 were killed and 88 were injured; 91 of these accidents were at unprotected crossings, while 61 were at protected crossings. In the 136 accidents of automobiles driven into the side of an engine or train, 13 were killed and 97 injured. It is notable that 514 crossing gates were crashed into or through, however, with no casualties.

Killed and Injured in Highway-Crossing Accidents in Pennsylvania in 1933.

	Automobiles		Wagons		Pedestrians		Total		Per Cent of Total Accidents
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	
Unprotected Crossings	37	175	......	......	5	1	42	176	59.08
Protected by Gates	2	15	......	......	2	5	4	20	6.50
Protected by Watchmen	4	28	......	......	5	2	9	30	10.57
Protected by Bells	1	12	......	......	1	......	2	12	3.79
Protected by Flash Light Signals	11	46	1	1	5	1	17	48	17.62
Protected by Alarm and Audible Signals	......	......	......	......	......	......	......	......	......
Protected by Switching Crews	......	9	......	......	......	......	......	9	2.44
Total	55	285	1	1	18	9	74	295	100.00
Killed and Injured at Protected Crossings	18	110	1	1	13	8	32	119	40.92
Per Cent of Total Killed and Injured	92.14		.54		7.32		100.00		......

New Book

Signal and Control Manual for Miniature Railways, by W. K. Walthers, 6 in. by 8 in. loose-leaf, flexible leather binding. Published by W. K. Walthers, 1414 W. Walker street, Milwaukee, Wis., Price $5.

The booklet is divided into thirteen sections, and additional sections are to be issued from time to time. Block signaling, automatic train control, interlocking, etc., are dealt with, giving the history of each system and explaining in detail how to construct and install each type of equipment on miniature railways. The manual is well illustrated with reproductions of photographs and drawings. Such information is, of course, essential to those constructing miniature railways as an avocation, and in many respects the booklet would be of interest and value to signal engineers of standard railroads, because many of the ideas of control developed for use on miniature railways might be applicable in other fields.