GCPs can be used for various types of grade crossings

This is an abstract of a talk made by R. J. Marks, western regional manager, Marquardt Corp., before a sectional meeting of the C&S Section, AAR.

By R. J. Marks

One of the more basic applications uses two Grade Crossing Predictors looking down the main line and protecting both approaches. GCP No. 1 protects the main line to the left, and GCP No. 2 protects the main line to the right. The symbol at the very end of each circuit is the approach termination, which is a short circuit from rail-to-rail that completes the GCP circuit. It is placed out at a distance that would be similar to a conventional start. Note 1 shows the use of a battery choke in series with a DC track battery. A choke is required wherever a track battery is within the GCP approach to provide AC isolation. In other words, the battery choke passes DC, but effectively blocks AC and prevents the battery from short circuiting the GCP signal (see Fig. 1).

Now in order for the GCP signal to go out beyond the insulated joints at the battery cut, it is necessary to pass the GCP signal around the insulated joints. Note 2 shows the use of wide band shunts, which provide a bypass for the GCP signal around the insulated joints. These wide-band AC shunts have no effect on the DC signal.

The GCP now has a complete circuit down one rail through the bypass shunt around the insulated joint, down through the termination shunt at the approach end, and back through the bypass shunt around the insulated joint to the return side of the circuit.

When a train enters the approach of No. 1 GCP the front trucks of the train shorten the GCP impedance circuit. The GCP computes the change of impedance in the circuit as the train moves towards the crossing. This computation is the analog of the distance to the train. The rate of change of this distance is proportional to the speed of the approaching train. Knowing the train's distance and its velocity towards the crossing, the GCP computes when the train is the required warning time from the crossing. At that time the GCP control contact releases the XR relay.

The GCP control contacts shown by note 3 are actually the minimum distance, self-check, and prediction contacts of each unit; but, for simplicity, they are shown as one contact.

As the train moves through the crossing and the last trucks clear the minimum distance of GCP No. 2, the crossing protection clears. If the train stops in the No. 2 GCP approach circuit and reverses towards the crossing, the No. 2 GCP will start the crossing protection in exactly the same manner as described for the No. 1 GCP. Stick circuits are not employed as with conventional circuits. Each GCP is independent of the other resulting in normal warning regardless of which approach the train is occupying or the type of move involved.

In Figure 2, is the same basic application plus a switching lead into the main track controlled by GCP No. 2.

The No. 2 circuit is a little out of the ordinary in that the GCP signal is routed down the siding to accommodate switching moves. A switch circuit controller is used in this application. In the normal position of the switch circuit controller (note 4) the insulated joint in the main line is shorted out and the insulated joint in the switch point is open-circuited, so the circuit for the No. 2 GCP is down one rail to the termination shunt, back through the switch circuit controller by passing the one insulated joint in the main line, and back to the return side of the GCP. When a move comes out of the siding, a member of the train crew will throw the switch. This reverses the switch circuit controller contacts. The insulated joint in the main line is now open-circuited and the insulated joint at the switch point is short-circuited. The GCP signal is routed down one rail, through the switch circuit controller to the termination shunt on the siding, and back the other rail to the second switch circuit controller that bypasses the insulated joint and returns to the other side of the GCP line. When a train comes out of the siding the GCP can follow the train as it approaches and give a normal warning.

The second switch circuit controller provides protection down another siding, if required. The GCP energy is routed down the second siding in the same manner as the first siding. Generally speaking this application is used in non-signal territory, but can be extended to signal territory. An installation of this type was made in San Antonio last year on the Missouri Pacific.

A 40 amp constant voltage rectifier supplies DC power to the Grade Crossing Predictor and also furnishes a float charge for the battery. When AC power goes off, the standby batteries take over and operate the GCPs.

For the two GCP track wires, an equalizer is used from line-to-line, and arrestors are used from line-to-ground. In addition to this, light-

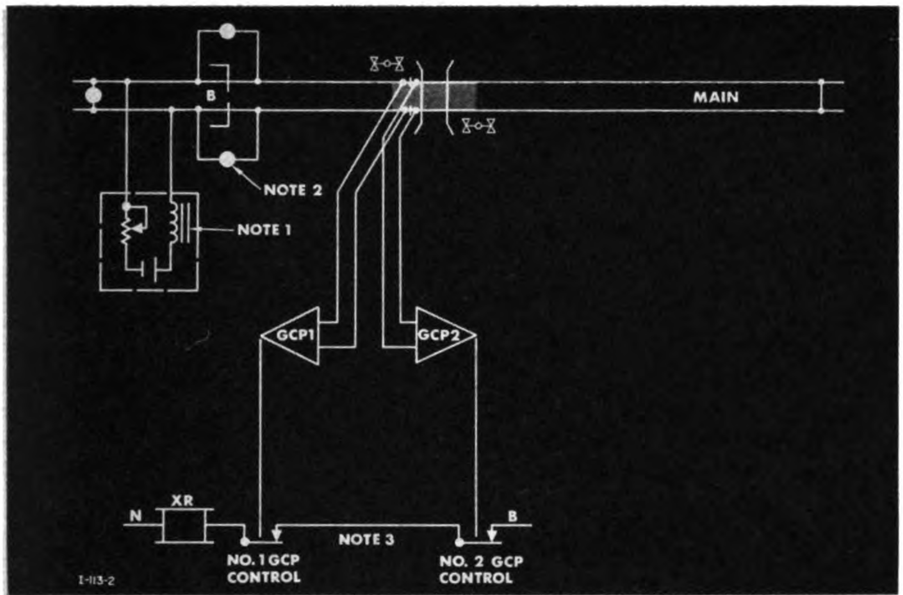

Figure 1—Basic application using two Grade Crossing Predictors.

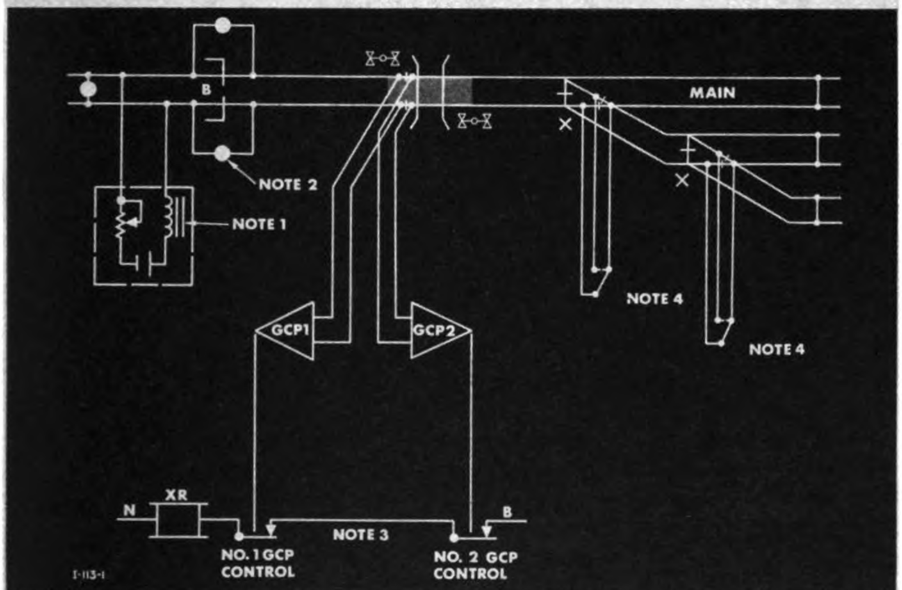

Figure 2—A switching lead is added to the basic type of crossing.

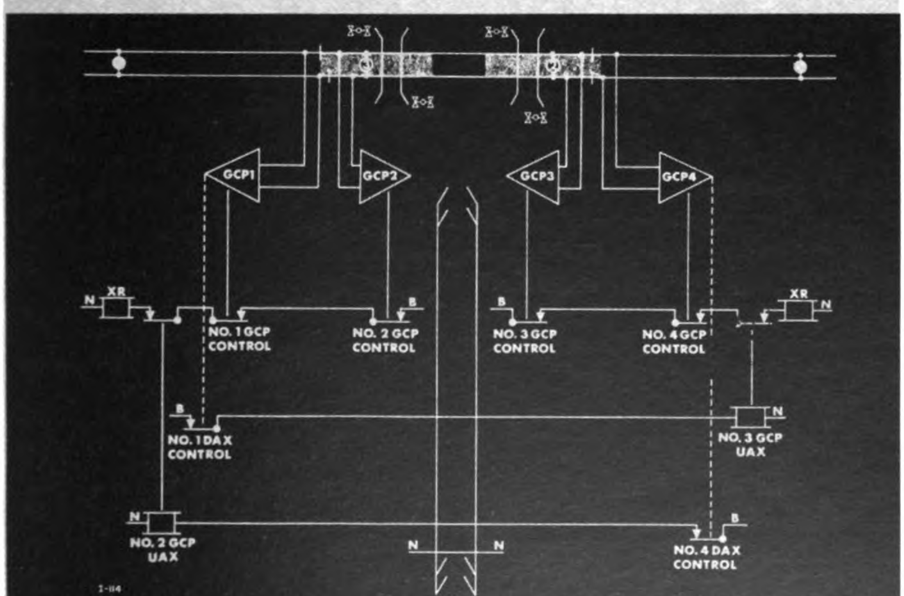

Figure 3—Use of GCPs for protecting adjacent grade crossings.

ning and voltage surge protection is also built into the GCP.

The wide band shunt is a large capacitor of 80,000 microfarads. It is potted for direct burial into the ground at a depth below the frost line or three feet, whichever is greater. After burial, one wire goes on one side of the insulated joint, and the other wire on the other side, forming a bypass circuit around the insulated joint. Where this shunt is used for the approach termination, the wires are, of course, connected from rail-to-rail. Two of these shunts are required to bypass a battery or relay cut, one for each insulated joint. The battery choke is installed directly in the battery box along with the DC battery.

The shaded portion of the crossing (Fig. 1) is the minimum distance circuit of the GCP and it is a positive ringing circuit that takes the place of a conventional "island or street" circuit. Whenever a train is shunting inside the minimum distance area, the minimum distance relay is dropped out. This circuit is necessary in the event the train stops at the crossing. The GCP will compute that the train has stopped and, therefore, the prediction relay will pick up. The dropped minimum distance circuit breaks the XR circuit in this case.

Figure 3 shows the use of Grade Crossing Predictors to protect overlapping or adjacent crossings. On the first crossing to the left, GCP No. 1 looks out a full approach distance to its termination. GCP No. 2 is looking to the right, but its signal cannot bypass the insulated joints at the adjacent crossing. The circle with the number 2 enclosed is a termination shunt for GCP No. 2. Next, taking the crossing to the right, GCP No. 4 looks out a full approach distance into its termination. GCP No. 3 looks out to the left to its termination (designated by the number 3 enclosed by a circle) located at the first crossing.

Adjacent crossing computations are made in the GCP No. 1 for eastbound approaches and by GCP No. 4 for westbound approaches. An adjacent crossing prediction will release the DAX control contact 30 seconds before the train reaches the adjacent crossing, but only on higher speed trains. On slower speed moves, adjacent crossing predictions are not issued. Predictions for these

In a special application, one GCP may protect for either-direction moves.

moves are furnished locally by GCP's No. 2 and No. 3.

UAX designates upstream adjacent crossing. DAX designates downstream adjacent crossing. The interconnections between the crossings are the pole lines that run from No. 1 GCP DAX control to the No. 3 GCP UAX relay and from No. 4 GCP DAX control to No. 2 GCP UAX relay. Also, a common negative battery is required running from instrument case to instrument case.

The shunts designated by No. 2 and No. 3 in between the two crossings are narrow-band AC shunts; in other words, they are series-resonant circuits that are resonant to the frequency of GCP No. 2 and GCP No. 3, respectively. GCP No. 2 and GCP No. 3 will be operating at overlapping frequencies.

Figure 4 is a special application that has been put into service in various locations and working out very well. It is a technique using one GCP to protect for moves from either direction, depending on selection of track relays. The ETR relay and WTR relay designate each approach relay. When the track is unoccupied, the transit wires of the GCP are applied to the east track through the picked contacts on the east track relay and the west track relay.

In the control contact portion showing the self-check (SC), prediction (PRED), and minimum distance (MD) contacts, battery is not applied through these contacts until a train moves onto the west track circuit or east track circuit. This is a wrap-around circuit enabling the XR to remain picked up as long as both track relays are energized. This means, for example, that if self-check dropped out with no train on either approach, the crossing protection would not operate until a train moved into either ETR or WTR.

A train enters on the west track circuit. The WTR drops; this applies the GCP transmit circuit through the picked-up contacts on the east track relay across the dropped contacts of the west track relay and out to the west track. The GCP is now looking in the direction from which the train is approaching. When the train gets inside the GCP circuit, the GCP computes a prediction and the prediction relay releases the XR circuit. The GCP has control of the XR when the WTR drops. The XR relay has a diode across it for two reasons: one . . . . to provide arc suppression and . . . . two . . . . to make it a slow release relay. This is necessary to keep the XR from dropping out momentarily during the switching from ETR to WTR.

When the train reaches the crossing and occupies the east track circuit, the ETR drops. When the caboose clears the west track, the WTR picks up and releases the GCP to look out the east track circuit and the GCP watches the train as it recedes. The crossing will clear when the train leaves minimum distance and the prediction relay will pick up on the receding train move. Should the train stop on the east track and reapproach the crossing, the GCP will furnish a normal prediction. When the train leaves the circuit, the ETR picks up and restores the GCP to a standby condition looking onto the east track circuit. This application may also be made with the GCP connected to a dummy track load when east and west tracks are occupied.

This application is not recommended where an engine will frequently spot a car on one side of the crossing and then go to work on the other side unless special timeout circuitry is employed. In the application shown here, if both tracks are occupied, both track relays would be dropped and the GCP control contacts would lose battery power and would have no control over the XR. This would result in continuous ringing.

Note 3 states that the DC circuit must extend an additional 5 seconds beyond the GCP termination shunt for the maximum speed train. This is necessary in order to provide adequate time for switching transients to be cared for.

The inductance that is inserted in series with the transmit wires going to the west track circuit, shown by note 1, is to nullify the minimum distance (MD) when the GCP is applied to the west track circuit. Normally, if this inductance was not in use, the shaded portion depicting minimum distance would extend an equal distance on the west track as on the east track resulting in considerable over-ring. The value of the inductance used would be equivalent to the amount of track that is equal to the width of the crossing. The letter designations P1C, P1D, and P1A are the connections on the Grade Crossing Predictor terminal board. **RS&C**

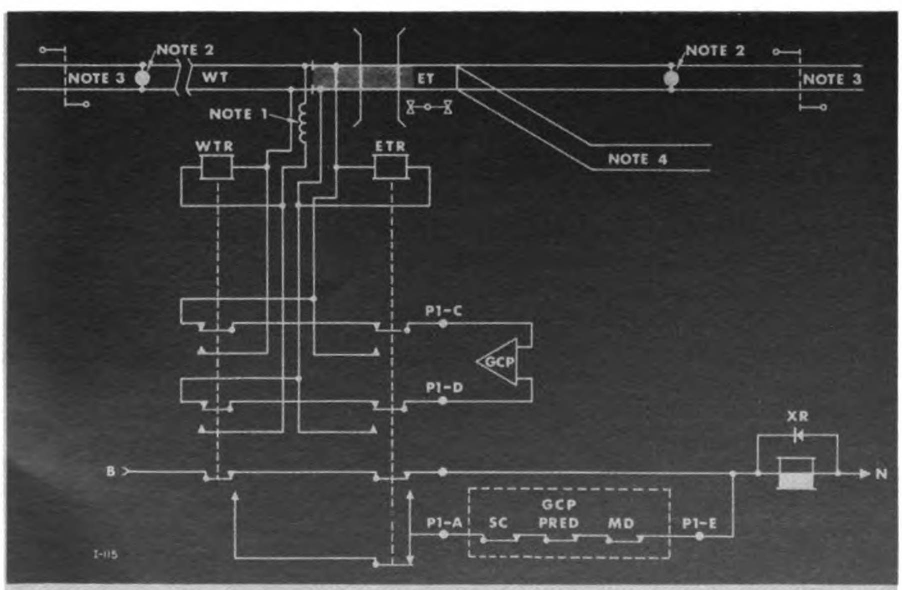

Figure 4—One GCP may protect for moves from either direction.