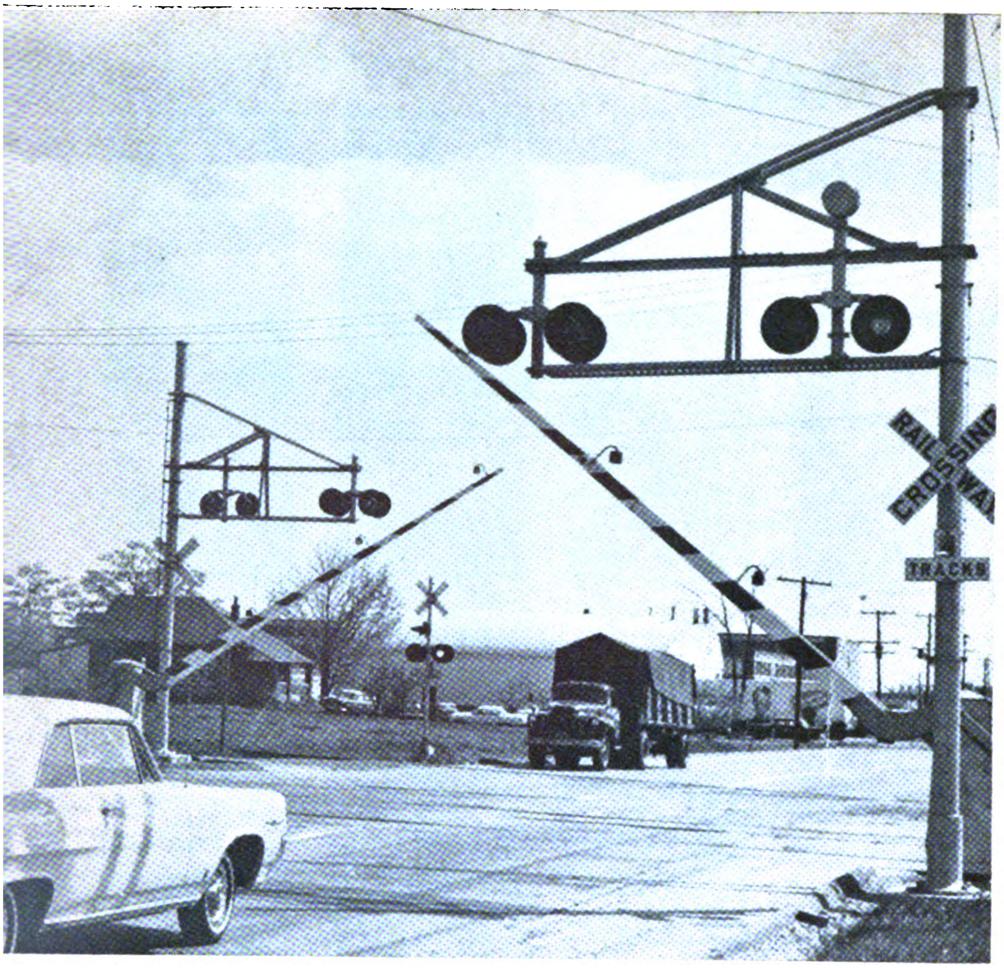
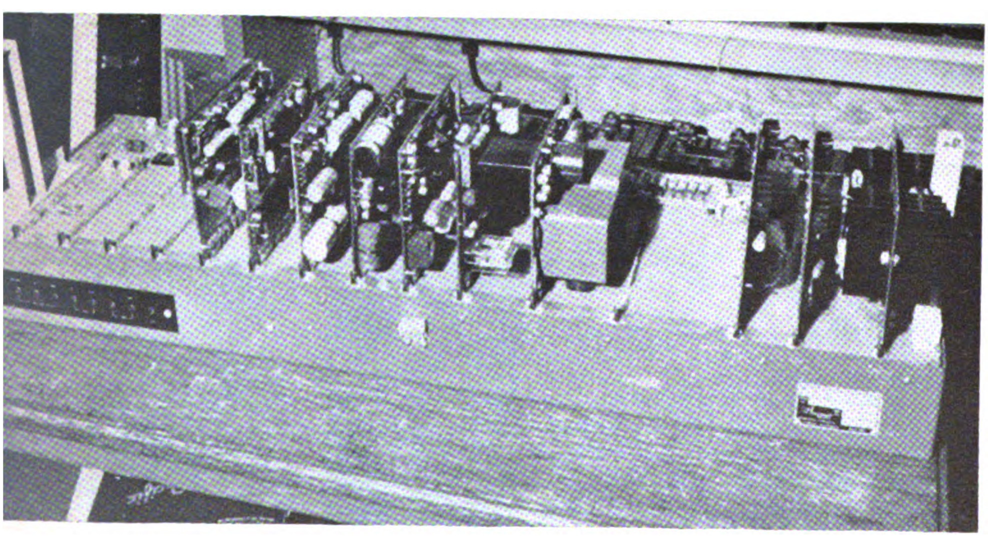


CP installs automatic gates and flashers at N. Queen St., Toronto, Ont.

Gate Control is by GCPs



Four model 200 Grade Crossing Predictors are used at this crossing.

In an industrial area of southwest Toronto, Ont., the Canadian Pacific has installed flashing-light signals and short-arm gates at the North Queen street crossing of its Canpa subdivision. To provide fully automatic operation without resort to pushbuttons for manual control during switching operations, CP installed model 200 Grade Crossing Predictors made by the Marquardt Corp.

North Queen, a 45-ft, 2-lane, road (4 lanes at the crossing) crosses the double-track mainline and two side tracks at the west edge of Islington service yard. This 5-track yard is used for the make-up of local trains doing industrial switching in the area. A normal practice is for a westward train to set off the caboose clear of the yard switch and then proceed to build the train on the main track. Cars are shoved back on the main track until the train is complete and then it proceeds westward. Eastward trains and industrial assignments frequently stop in the vicinity of the crossing to telephone the yardmaster to establish whether there is more work for them to do. Cars are frequently left standing on all approaches to the crossing for long periods of time, and all switches within the approach circuits are used daily. Often there will be two engines working in the vicinity of the crossing, one on each main track, and on occasion there have been three. Of the total of 80 train and engine movements over the crossing daily, 8 to 10 of them are through freight trains. Maximum speed in this territory is 25 mph.

To add to the railroad activity at the crossing, there is considerable vehicular traffic, particularly trucks serving plants and ware houses in the area. Vehicular traffic is particularly heavy around 8 am and 5 pm. Prior to the installation of automatic crossing protection, switch crews had to flag the crossing. "You took your life in your hands to get out and flag the street at rush hour," commented one switch crew member. This man reported that the automatic protection has not only made it safer for them, but now there is less delay to switching moves and vehicular traffic.

Four Grade Crossing Predictors were installed at insulated joints on the two main tracks. These joints are opposite and just off the west edge of the N. Queen street pavement. A pair of GCPs is on each main track looking away from the insulated joint. DC track circuits, approximately 200 ft long, were installed on the two side tracks (spurs). DC circuits were installed on the two main tracks on either side of the insulated joints as part of a proposed CTC system, alough they were also to form part of e crossing project.

The N. Queen street approach cir- uits for the GCPs are 1,050 ft long n the two main tracks, and are de- ned electrically by narrow-band unts. These shunts are tuned circuits mpletely encapsulated and buried in e ground adjacent to the tracks. The sulated joints at the approach point r the protection of the nearby cross- g of the Queensway are by-passed y AC wide-band shunts (completely ncapsulated). The approach circuits n both main tracks provide a 30-sec arning time for the crossing, in addi- on to an allowance of 2 sec equip- ent time for the GCP. For a normal raight-through move, the flashing ghts are set into operation 30 sec efore the train arrives at the crossing. bout 3-5 sec after the GRS flashers egin operation, the Griswold gates re lowered. The GCP equipment rovides a positive ringing section or minimum distance" which is set for pproximately 35-40 ft beyond the avement edge (width of the pave- ent at the crossing is 45 ft).

The DC track circuits east of the rossing extend well beyond the 1,050 t approach circuits for the crossing. he track circuits west of the crossing, hen combined with the adjacent ircuits for the crossing protection at he Queensway, also extend beyond he 1,050 ft GCP circuits.

An Esterline-Angus 20-pen recorder vas installed in the bungalow at the rossing to provide a graphic record f the operation. Pens record the fol- owing information: dropping of the rack relays for the eight DC track circuits; "prediction" and "self-check" relays of the four GCP units; and two of the four "minimum distance" relays; the XR relay for the gates and the ECP relay for the flashers.

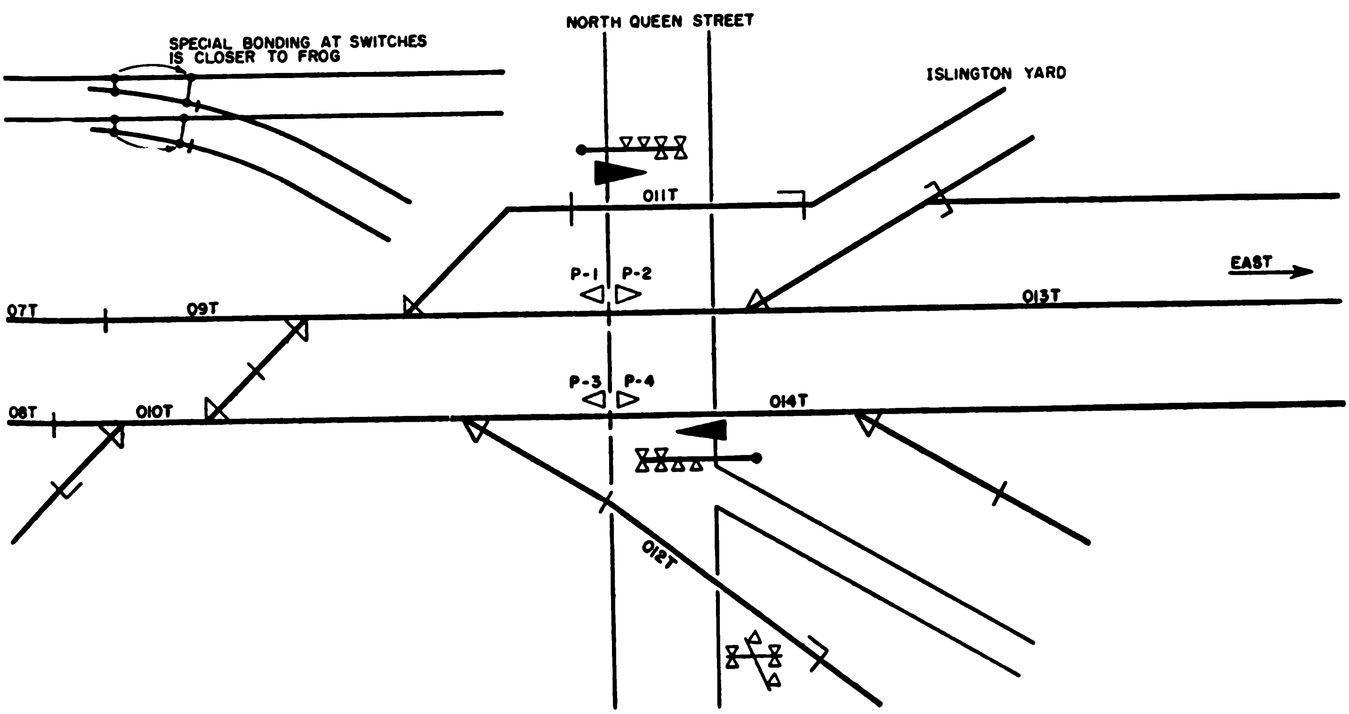
The recorder chart is normally running at the very slow rate of ¾" per hr and in order to provide accurate measurements of the operating times, the recorder shifts to ¾" per min when an approaching train occupies one of the DC track circuits. These track circuits have another role in the crossing protection operation. The GCP equipment is self-checking, that is, every four or five seconds a self-check circuit completely proves the correct operation of all circuits in the unit. If for any reason the check is not successful, a relay releases which would normally lower the gates. In this instance it was felt undesirable to tie up traffic in case of a failure. Therefore, the DC circuits are arranged to provide a "backup" for the GCP equipment. If for any reason, the GCP equipment does release its self-check relay, the gates will remain up unless the DC track is occupied by a train.

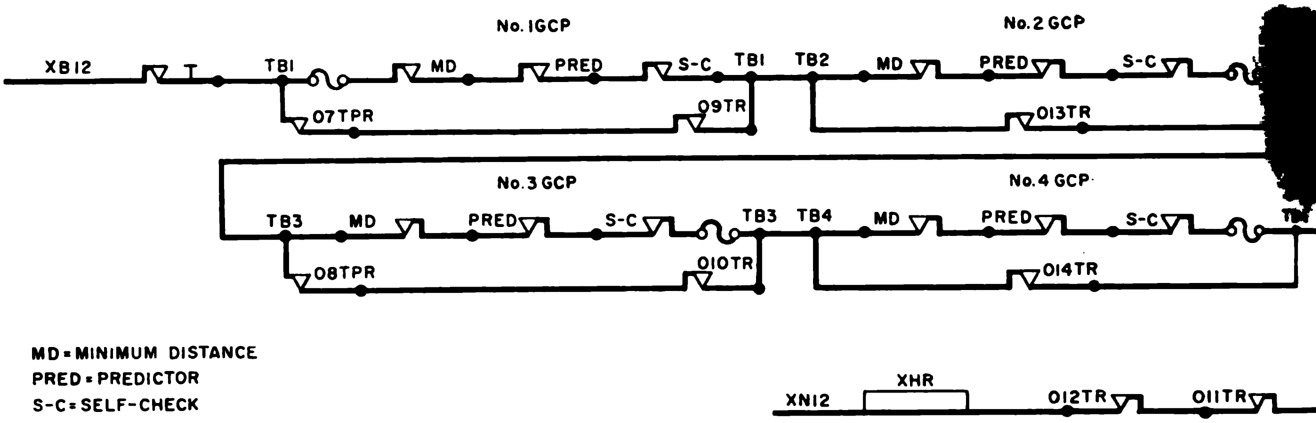
TO LOWER GATES

In other words, to lower the gates, the GCP equipment must have either detected the approach of a train or have failed at the same time the corresponding DC track circuit is down. There are no stick circuits provided for operation with the DC track circuits nor are there any other relief circuits whatsoever. This means that if under a failure condition the appropriate DC track circuit is occupied, the gates will be lowered regardless of the direction of the train movement and regardless of what movements it happens to be making.

The GCP units apply a constant 200 ma AC current to the rails. With the circuit unoccupied, the unit measures an inter-rail voltage of approximately 7½ volts at the crossing. A train approaching the crossing causes the measured voltage to be lowered more or less proportionate to the distance the train is away from the crossing. By using the rate of change of the distance, the unit can also determine the train's speed, and thus can determine when the train is 30 sec away from the crossing. To provide prediction for the two spurs, or sidetracks, the switches are insulated and bonded in such a way that the GCP units "look down" the fouling section away from the crossing. The bonds are closer to the frog than in conventional switch bonding. This bonding arrangement has been generally successful and works satisfactorily for trains approaching the crossing on the spurs at 10 mph, a normal speed. However, if the engine or train approaches at a lower speed, the protection equipment may operate intermittently until the DC track circuit is reached. This idiosyncrasy is well known to the crews and experience to date indicates no difficulty is encountered.

The why of this discontinuity of operation for a slow move over the switch is as follows: Experience at this N. Queen street crossing indicates that a train or engine moving over a switch and frog presents a complex electrical circuit, which causes slight discon-



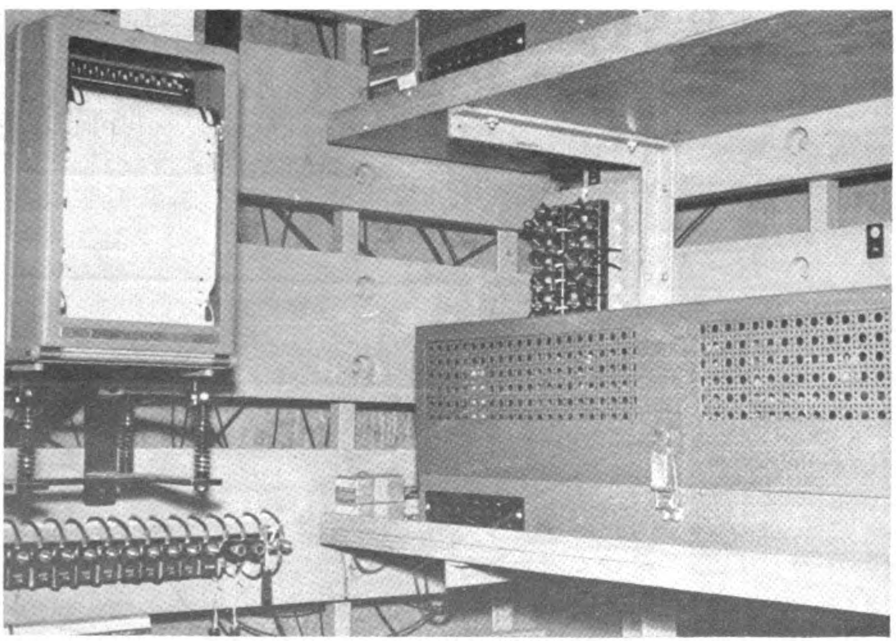


To drop the XHR relay, track circuits must be occupied as well as GCP unit operating.

tinuities in the GCP track circuit voltage. What happens is that the engine movement over the points and frog causes either a rapid fluctuation of the AC voltage or a leveling out of the slope of the voltage curve and thus causes a misleading input to the GCP. This has been overcome to a major extent by using a slow pick-up XR relay to control the gates. Except at very slow speeds the engine reaches the DC positive section on the spur before the XR picks up so that there is no premature raising of the gates at the crossing.

When a train or engine is making a move away from the crossing over the crossover reversed, there is a momentary operation of the flashers and bell because the train suddenly appears on the approach of the other main track GCP unit, and the voltage for this other GCP instantaneously drops to a much lower value. Thus, the GCP suddenly "sees" a train approaching at relatively close range traveling at infinitely high speed. Thus the protection is put into operation for a second or so, and then cuts off when the GCP discovers that the train is not actually approaching at such a high rate of speed. In those such cases when the flashers start operation, it is only for a second or two, not long enough to lower the gates.

For various reasons it appears that most of the through trains to move over this crossing are slightly accelerating (maximum speed is 25 mph). Because the GCP equipment is set up to predict for 30 sec operation and the crossing only requires 22 sec operation, this acceleration is handled very well. For example, if a train enters the approach circuits at a certain speed, the GCP equipment predicts when the train is 30 sec away. If the train is accelerating, it will actually reach the crossing in somewhat less time. Even under these conditions, examination of the recorder chart shows that the protection equipment regularly operates between 22 and 30 sec before the train reaches the crossing.



Recorder with 20 pens is in bungalow along with GCPs (far right).

For switching movements on the main tracks, the CP reports that the GCP equipment predicts extremely well. For the frequent movements out of the yard, normal ringing time varies between 10 and 16 sec at the speeds generally used and is, therefore, long enough for the gate arms to be fully lowered. It should be noted that this approach is relatively short and that the operation obtained is not only satisfactory but the best possible without restricting train speeds or requiring a stop. Switching movements that stop within a reasonable distance of the crossing on other approaches achieve similar warning times. These warning times are sufficient to insure that the gates are fully lowered before the train reaches the crossing.

After some experience had been obtained with the operation of the GCP equipment it was noted that the minimum distance setting was varying quite widely. The track connection cable from the GCP is a twisted pair and had been installed with a slack loop to provide for any track or joint changes that might occur in the future. This variation in minimum distance setting of the GCP was practically eliminated by removing the slack loop in the cable.

Initially, some interference was experienced from overhead high-voltage power lines of Ontario Hydro, which has three lines in the area: 26 kv, 110 kv and 230 kv. The original frequency used at N. Queen street was 285 cps. It developed that there was a very strong 300 cps frequency being radiated to the rails. This 300 cps frequency caused a 15 cps beat which produced a steady variation in the minimum distance setting. This was overcome by changing the 200 ma constant current frequency to 156 cps.

Power required at the crossing is about 15 amp at 110 volts, AC. Each GCP unit draws approximately 5 amp at 8 volts, thus the four GCP units draw 20 amp. Two separate banks of

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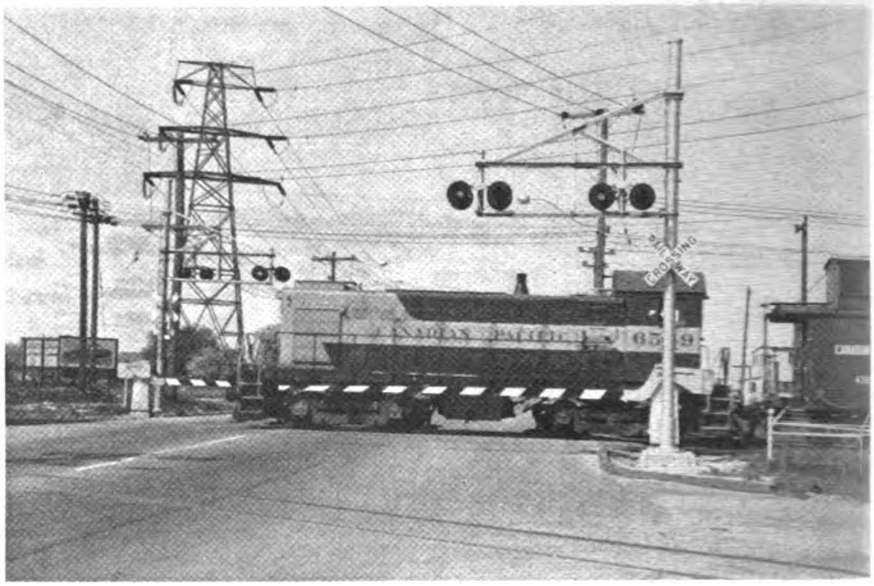
(Continued from page 32)

Nife battery were installed of sufficient capacity to handle a power outage, one bank for each track. A third bank is used to handle gates (operate on 12 volts DC) and lights.

A test panel on the side of the bungalow is for the section foreman or signal maintainer to test the crossing protection equipment operation. Pressing a button causes the equipment to operate, and the gates go down. Release of the button raises the gates and cuts out the flashers. A test is made at least once a week.

A shunt or short circuit on the rails is no more of a problem, than with conventional equipment reports CP signal engineers. The shunt appears to the GCP equipment as though it were a stationary train. This means that the equipment will operate the crossing protection for a second or so and then cut out. Since the flashers normally operate 3-5 sec before the gates are lowered, this momentary operation will be observed as only one or two flashes of the lights and two or three rings of the crossing bell clapper. However, an approaching train will not operate the crossing protection thereafter until it is closer to the crossing than the shunt. If it is moving sufficiently fast to reach the crossing in less than 30 sec, it will immediately start the protection at the moment it passes the shunted point. With conventional circuiting, when a short on the track caused a timing circuit or directional stick to be retained, the train would not cause the protection to operate until it reached the next restart point closer to the crossing.



Initially, power lines caused interference with GCP track circuits.

A broken rail within a reasonable distance of the crossing (although not determined, but assumed to be at least 500-600 ft) will cause the equipment to saturate and release the self-check relay. For example, if the DC track circuit is down or is dropped by a train, the protection equipment will immediately operate.

CP engineers point out that as soon as a train slows or stops so that it is more than 30 sec away from the crossing, the gates will immediately raise. If the train again moves toward the crossing and is close to the crossing, the gates will immediately lower, or if it is further away from the crossing flashers and gates will be operative as soon as the train reaches the speed such that it is 30 sec from the crossing. This, of course, is a major feature of the equipment because with normal DC track circuits the protection would not operate until the train had reached the next "start" point. For practical purposes, says CP signal engineers, the GCP equipment provides an infinite number of start points.

STARTING POINT ANYWHERE

This feature of a starting point anywhere, was one of many reasons for selecting GCP equipment for this crossing. A study made to provide automatic protection with conventional DC controls indicated that at least 12 separate timing circuits would be required on the mainline. Additionally, pushbuttons and key switches would be necessary in order to minimize unnecessary operation of the signals. It was felt that the operation of manual control devices by train crews would inconvenience train traffic and still, there would be considerable unnecessary operation of the crossing protection equipment which would lead to highway traffic delay and/or non-observance of the warning devices. The total cost of such installation was estimated at close to $60,000. (Canadian prices are approximately 15-20% higher than in U.S.)

All equipment for this crossing was fitted into a 6 x 8 ft bungalow, including the four GCP units, three banks of batteries, several relays, rectifiers, the operation recorder, etc. Except for the fact the installation was new and therefore unfamiliar and that much experimentation had to be done, CP engineers report that labor charges for such an installation would be quite low, as there is very little wiring work to be done and a negligible amount of underground cable, etc. to be installed. The final cost for the job was approximately $43,000. Of this, the GCP equipment including one complete set of spare equipment, and including two constant voltage battery chargers totaled approximately $12,000.

The installation work was directed by Garnet Pinkney, signal supervisor under the jurisdiction of Douglas H. Walkington, regional signal engineer. RS&C