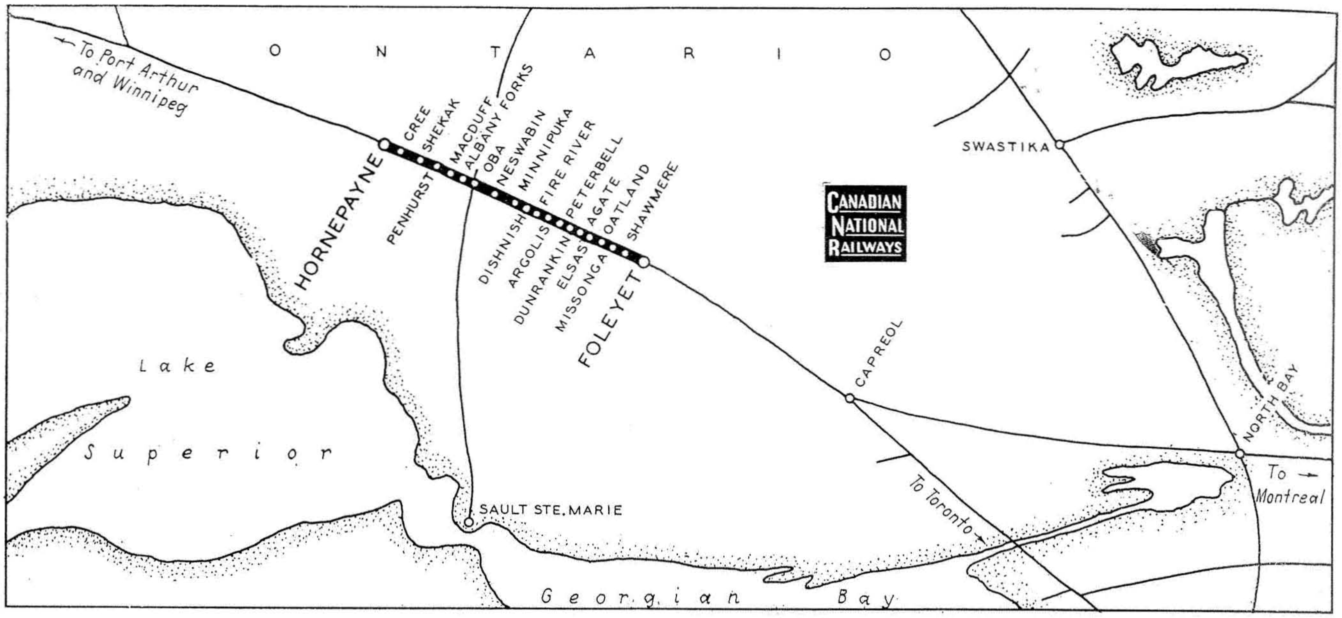


Fig. 1—The Oba subdivision, equipped with CTC, is about halfway between Montreal and Winnipeg

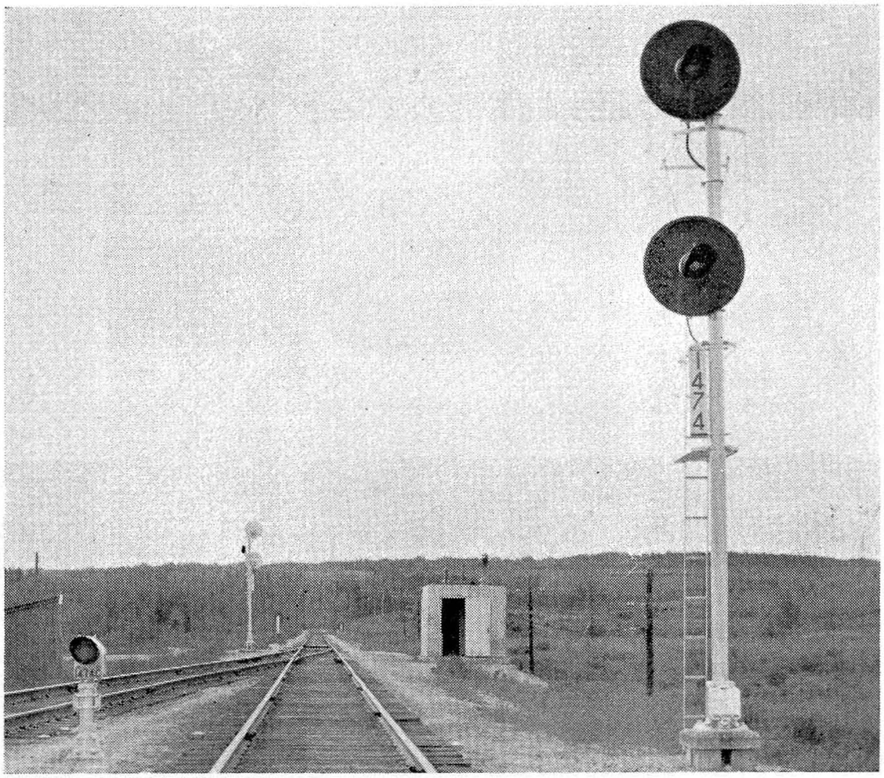
Canadian National Adapts C. T. C. to Traffic of 12 Trains Daily

Important objective of train operation by signal indication is accomplished by simplified system based on siding-to-siding block and with power switch at one end of sidings and spring switch at the other, thus reducing costs in proportion to volume of traffic on a 148-mile subdivision

ON A SINGLE-TRACK, 148-mi. subdivision, that has 10 to 12 scheduled trains daily, the Canadian National installed a centralized traffic control system, in which the costs of the project were reduced in proportion to the traffic. This installation has a power switch at one end of each siding and a spring switch at the other. Overall blocks extend from siding to siding, with no provision for following moves in such a block. This saved on intermediate signals. Thus, for a cost not too much more than for complete conventional automatic block, the Canadian National attained the important objective of train operation by signal indication, as well as avoiding a very high percentage of train stops when entering and leaving sidings.

This new signaling is between Foleyet, Ont., and Hornepayne, Ont., 148 mi. of single track, known as the Oba subdivision which is part of the Canadian National transcontinental route from Halifax on the Atlantic to Vancouver on the Pacific. Lines from Montreal and Toronto join at Capreol, as shown on the map. From Capreol, the line extends west, and slightly north, through the territory north of Lake Superior, Oba being about 200 mi. directly north of the Sault. In general, the railroad is located on the divide of land between the Great Lakes and Hudson Bay. Between Foleyet and Agate, 38 mi., there are numerous curves ranging up to 6 deg. The ruling grade eastbound varies from .2 to .4 per cent for about 9.5 mi. between Elsas and MP 22.5, east of Oatland. Between Agate and Hornepayne, 10 mi., the grades and curvature are light. Maximum permissible speeds are 60 m.p.h. for passenger trains and 50 m.p.h. for freight trains. Speed reductions to 40 m.p.h. are in effect at six locations, to 45 m.p.h. at one, and to 50 m.p.h. at six locations.

This Oba subdivision lies in typical north woods country, mostly wooded with spruce, pine, poplar and cedars, crossed by many rivers, heavily dotted with muskeg, and thousands of lakes some of which are several square miles in area, and can be termed a fisherman's paradise. There is no farming or industry in this territory except for a limited amount of lumbering and pulp wood cutting. No highways run through this area; therefore, except at Hornepayne, there are no highway crossings for practically 148 mi. Oba is a village of about 50 inhabitants and has the only grocery stores and hotels in the entire distance be-



This is the typical signaling at a power switch

tween Foleyet and Hornepayne, except for a Hudson's Bay Company store at Peterbell.

The Algoma Central crosses the Canadian National at Oba, 109 mi. west of Foleyet. Two sidings of 89 and 92-car capacity, one siding for passenger train meets, and a small interchange yard are located at Oba. Trains stop for fuel and water, and for inspection, at Fire River, at which point there is an extra long siding. Single sidings, located at 15 other places, range in capacity from 77 to 82 cars. At one end of each of these sidings, there is a short set-off track to hold bad-order cars or camp cars used by track gangs.

Why the Oba was Signaled First

Previously, there was no signaling on any of the entire 1,083 mi. between Capreol and Winnipeg. The Oba subdivision was chosen to be signaled first because the three eastbound passenger trains are scheduled to meet the three westbound passenger trains on this 148 mi. every afternoon. Also, the fast merchandise freight trains, on run between Montreal or Toronto and Winnipeg, are scheduled to meet on this subdivision. Thus, the number of trains varies from an early morning low to a mid-afternoon peak, which for a few hours is at the rate of practically 60 trains a day, although the actual total for the 24 hr. may range from a low of 10 trains to about 16, with unusual peaks of 18 to 20. Three passenger trains are operated each way daily in the summer, July 1 to October 1, and two each way are operated daily in the remainder of the year. Six manifest freight trains are scheduled daily. Freight traffic, such as merchandise and manufactured products, varies from a low on Monday and Tuesday to a high on the week-ends. During the winter, after navigation closes on the lakes, about four trains of loaded grain cars are handled eastward daily from about Dec. 1 to April 1.

Because of the isolated locations of offices, it was difficult to secure enough good operators. The dispatcher had to work with information from eight day operators and five night operators, or roughly from every other of the 17 sidings in the peak period of the day. Each open office held a 20-minute time block behind each passenger train. During winter, trains were operated on absolute block which required 13 extra operators. The situation was beyond the capabilities of the train order system to get trains over the subdivision in reasonable time.

Freight trains commonly took nine, ten or even more hours between Hornepayne and Foleyet, an effective speed of about 15 m.p.h. Some freight trains were unable to depart from Foleyet or Hornepayne in the late forenoon and early afternoon, when passenger train time was near. Delays were so serious that they affected the overall east-west performance of the railway.

Decide to Install C.T.C.

The Canadian National for several years has had complete C.T.C. in service on two subdivisions with heavier traffic, one from a point near Montreal to Levis (Quebec), and a second from Moncton, N.B., to Halifax, N.S. Based on the excellent results on these territories, a logical thought was to install C.T.C. on the Oba subdivision. However, in this instance, with a total traffic of as low as 10 trains daily, a decision was made to install, at first, something less than full CTC, in order to reduce the cost somewhat in accordance with the volume of traffic. Also, the Canadian National faced the fact that similar signaling is needed on the remainder of the entire 1,083-mi., Capreol-Winnipeg link between Eastern Canada and Western Canada. Therefore, funds available for signaling had to be spread as thin as was consistent with securing safety and train operation by signal indication.

Switch and Signal Arrangement

The typical arrangement of signals and switches, in this modified CTC, is shown in Fig. 2. A power switch is located at one end of each siding, and a spring switch at the other. At each power switch there is a standard arrangement of signals to

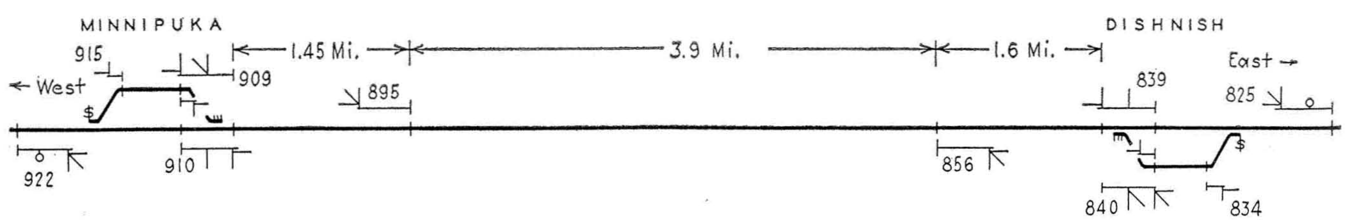
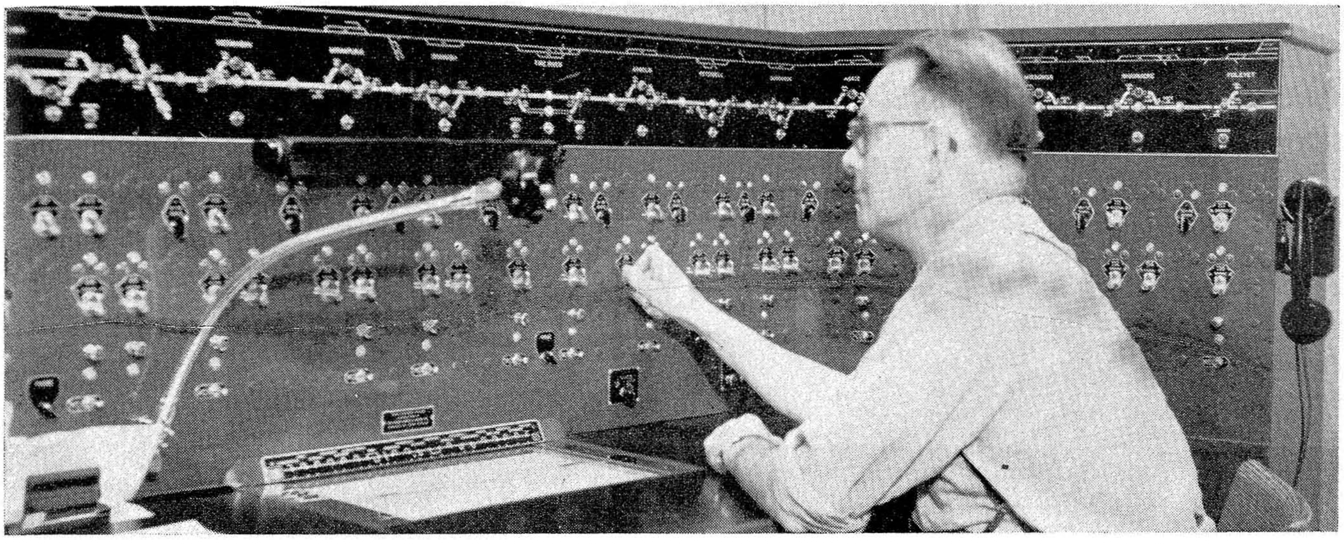


Fig. 2—Plan of signaling for siding-to-siding block



The CTC control machine is in the dispatcher's office at Hornepayne

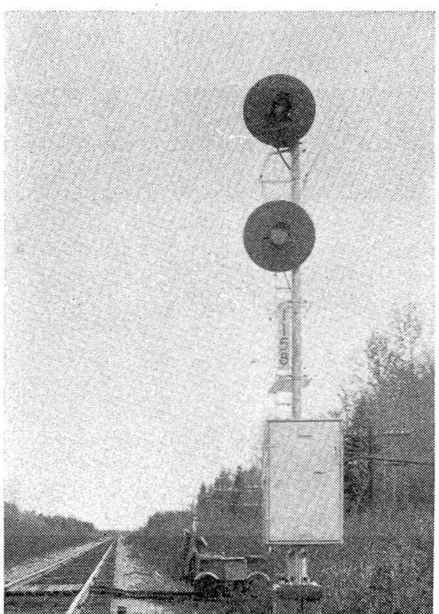
direct trains to: (1) continue on the main track; (2) enter the siding; (3) leave the siding, or (4) stop. At the spring-switch end, there is a CTC controlled dwarf signal to direct a train, on the siding, to depart. This move is made by trailing out through the spring switch, and, therefore, no stop is required to permit trainmen to handle the switch.

As a general rule, trains enter a siding at the power switch end, and depart at the spring switch end. However, signaling is arranged to direct a train to enter a siding at the spring switch end, if the dispatcher decides that train time can thus be saved. For example, if an eastbound train is to be directed to enter the spring switch end of Minnipuka, the dispatcher sends out a control to cause signal 92.2 to display an aspect of yellow over an illuminated lunar white marker which includes the letter "S." This aspect directs the eastbound train to stop short of the switch at the west end of Minnipuka. Then the head brakeman reverses the switch by using the hand-throw stand, so that the train then enters the siding. After the train is in the clear, the trainman places the switch normal.

In this arrangement of power and spring switches, if other factors are equal, maximum flexibility of train operations can be attained by locating the power switch at the east end of one siding, and at the west end of the next, etc. This procedure was followed except where local conditions dictated otherwise. For example, a spring switch was not installed at a location where a train is ascending a grade when pulling out of a siding, because, at such locations, it might be necessary for an engineman to back up to take up slack when getting his train started. Such a move on a spring switch might result in a derailment. Power switch machines are used at both ends of the sidings at Fire River where trains take water and at Oba where they take water and interchange with the A.C. Of the 15 other sidings, the power switch is at the east end of seven and at the west end of eight.

Siding-to-Siding Block, With No Flagging

Referring to Fig. 2, the block is from power switch to power switch. For example, from signal 910 at Minnipuka to signal 840 at Dishnish, or from signal 101 at Neswabin to signal 910 at Minnipuka. The signals which authorize a train to enter a siding-to-siding block, operate to display either red for Stop or green for Proceed, which indicates that the entire siding-to-siding block is unoccupied. There is no signaling to allow a following train to enter a block occupied by a train. With this practice, no flagging protection is required, except for unusual circumstances, this being an important factor, especially in severely cold weather. Also, the siding-to-siding block permitted some saving by eliminating intermediate automatic block signals, as such. The signals such as 856 and 895, between Dishnish and Minnipuka, are approach signals. For example, signal 856 displays the yellow aspect when signal 840 is at Stop, or when 840 is lined up for an eastbound train to enter the siding.

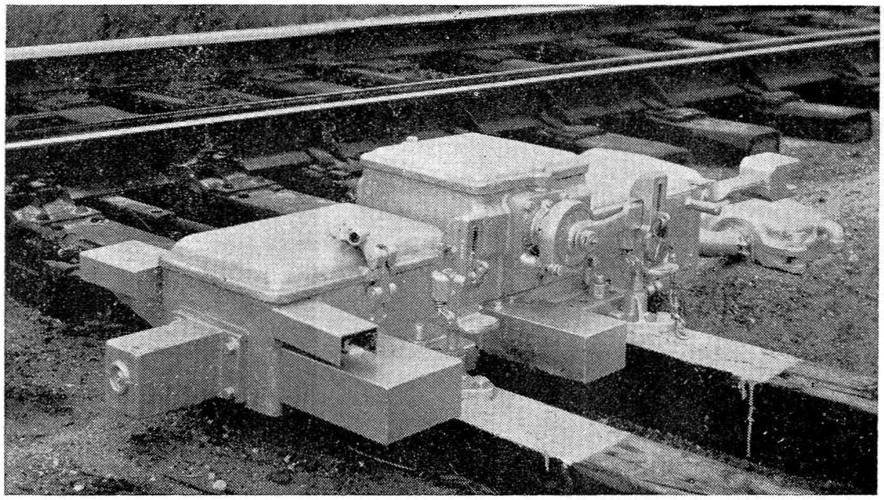


Lower unit displays lunar "S"

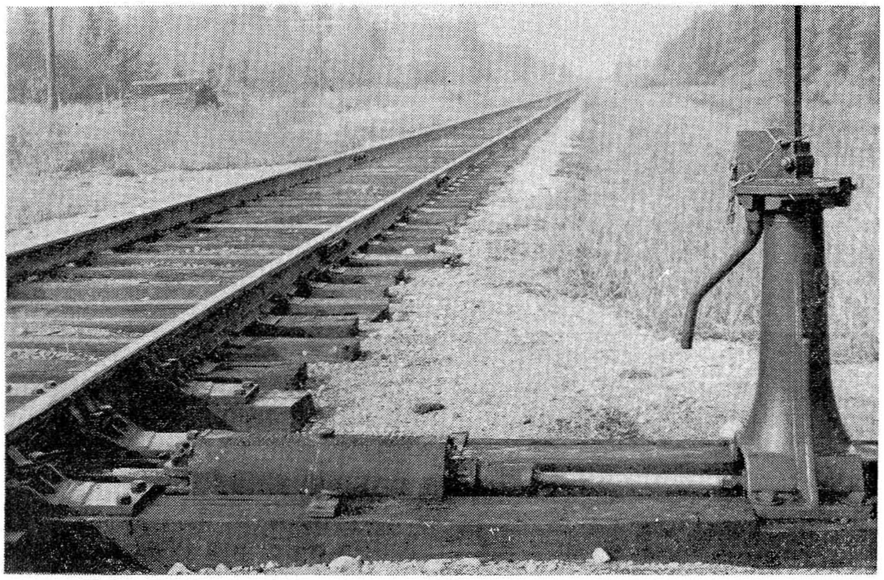
Saves Train Time

The CTC on the entire subdivision is controlled by one machine in the dispatcher's office at Hornepayne. The illuminated track diagram on this machine indicates the location and progress of all the trains, so that the dispatcher can control the signals to direct trains to make close meets. An important benefit is that the CTC has enabled the dispatcher to eliminate the train congestion which formerly occurred nearly every afternoon on this subdivision. Now he can handle the six passenger trains on schedule, and also keep the freight trains moving. Formerly, many of the freight trains ran into overtime (more than 12 hr.) but now, such a thing is unknown, except in case of cccidents.

With train order operation during the first three months of 1951, the manifest freight trains averaged 8 hours 19 minutes for the subdivision, as compared with 6 hr. 19 min. (under CTC) in the same months of



Aluminum paint minimizes condensation of moisture in switch machnes



Spring switch mechanism is part of throw rod

1952, a saving of about 2 hr.

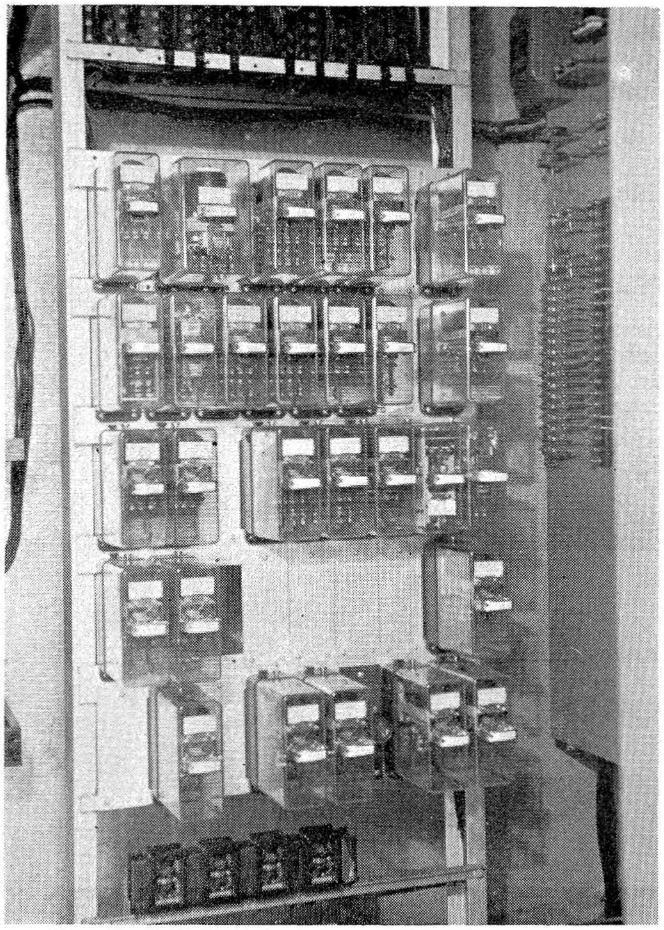
During the summer of 1952, an extensive reballasting project was under way on this entire subdivision, thus requiring numerous slow orders and many work trains. In spite of all this interference, the manifest freight trains saved an average of 1 hr. 8 min., and the drag freights saved 1 hr. 44 min. eastbound, and 1 hr. 18 min. westbound. These figures are for all such trains in July of 1951, compared with July 1952. With no slow orders or work trains in 1953, the operating officers expect that the time saving accomplished by the CTC will be about 2 hr. for manifest trains, and 3 hr. or more for other freight trains. The time savings are accomplished primarily by making closer meets by means of the CTC. For example, on September 25, passenger trains No. 2 and No. 3 made a non-stop meet at Minnipuka. In a meet between two freight trains at Neswabin that same afternoon, the actual standing wait for the eastbound train, on the siding, was only 35 sec., measured by a watch on the locomotive. The westbound train passed at normal speed. If train orders had still been in use, the westbound train would have taken siding at Minnipuka, 10 mi. east. Thus, in this instance the CTC saved about 40 min. for the westbound train, and did not delay the eastbound. On September 25, the same eastbound freight discussed above, continued east to Fire River to take siding at the west end while passenger trains No. 1 and No. 2 made a meet. Then all three trains were soon on the move again.

Previously, with train orders, two days were ordinarily required to run the snow plow in either direction between Hornepayne and Foleyet. With CTC this plow run is being made in one day. Previously, freight trains were not called to depart from Foleyet or Hornepayne in the late forenoon as time approached for the parade of passenger trains. Now these trains depart as soon as they are ready. No records are available of this phase of the time saved by the CTC, but the chief dispatcher states that ability to tell a train to leave Hornepayne or Foleyet, the moment he is ready, is saving many hours that were not shown on the train sheet previously. The final section of this project was placed in service on December 14, 1951. An immediate cash benefit was that the employment of the 13 extra operators to place absolute block in service during winter months was not necessary. In the course of a few months, other offices were closed either part or full time, so that 17 more operators were moved to offices west of the CTC, where they were needed badly. The saving in operating expenses, because of fewer operators, totals about $60,000 annually.

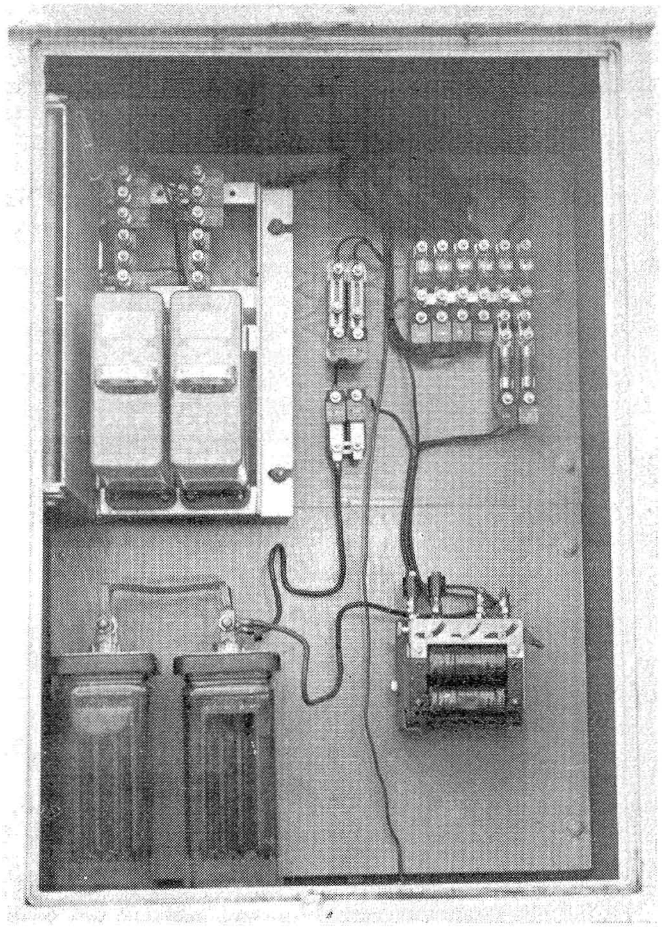
Previously, when all the siding switches were operated by hand-throw stands, the track crews cleaned the snow from the switches during and after snow storms, as part of their regular duties. Brooms and shovels were on hand, placed at the switches for trainmen to clean a switch if necessary when operating it. These same practices are being continued, with respect to the power switches and spring switches in the CTC. In the new concrete relay house at each power switch there is a separate room 7 ft. by 8 ft. with a stove, for use as a phone booth, and as warming room for track forces. In this area, snow falls as soft flakes, and the air is still, with very little or no wind in cold weather. Therefore, ordinarily, snow does not drift into switch points too much, after having once been cleaned, following a storm. If a spring switch does not close to the normal position after a train trails out through it, from the track occupancy indication, the dispatcher knows that the switch is not closed and can call the trackmen to clean the snow or other obstruction from the switch. Thus, in brief, the spring and power switches, as well as all the other signaling facilities in this CTC project, are operating successfully in an area 200 mi. north of Lake Superior where winter temperatures range from 25 to 40 below for weeks, and the record low in the past few years is 72.6 below zero.

Special Features of Control Machine

The control machine for the CTC on the entire subdivision is in the dispatcher's office at Hornepayne.



Plug-in relays save time



Instrument case at an approach signal

The track diagram has lines ¼ in. wide to represent the main track and sidings. The OS track circuit at each power switch is represented by a red track indication lamp, and each siding-to-siding section by a white lamp. These lamps are controlled by the track relays. Also, a white track lamp repeats occupancy of each section of main track parallel to each siding when a train is approaching the power switch end. No extra track circuit is required for this, the result being accomplished by an extra relay "floated" across the track battery at this end of the track circuit. The amber lamp on each section representing a siding is manually controlled by the small toggle switch on the panel below the respective siding. When a train goes on a siding, the dispatcher throws the toggle switch to light the lamp as a reminder to him of the direction in which the occupying train is headed.

An automatic train graph, countersunk in the desk portion of the control machine, has 30 pens to report the passing of trains at 30 OS locations. Each pen normally makes a straight line. When one of the signals governing over the OS section is cleared, the corresponding pen moves to the left ⅛ in. to make an offset in the line. When a train enters the OS section, the pen moves to a position ⅛ in. to the right of its normal position to make an offset in the line. Associated with the controls for each power switch layout there are two levers, one of which controls the power switch machine and the other to control the three signals governing train movements over that switch. As applying for the spring switch end of each siding, there is a single lever, which, when positioned one way, controls the leave-siding dwarf signal, and when positioned the other way, controls the "take-siding" aspect of the signal in approach to the spring switch end of that siding. Applying to the straight track between any two sidings, there is a traffic direction lever in the same horizontal row as the switch levers.

These traffic direction levers are the push-turn type. They normally stand on center, and are ordinarily not used because traffic direction is established as a preliminary part of controls sent out to clear a siding-to-siding signal. If traffic direction is to be established without clearing such a signal, then the push-turn traffic direction lever is used. For example, if the local freight is to be directed to leave a sawmill spur in a station-to-station block, the traffic direction must be set up by the traffic lever so that the train will not encounter a stop aspect at the approach signal. Also, there are other circumstances in which the traffic direction in a station-to-station block must be established independent of the clearing of a signal for that block.

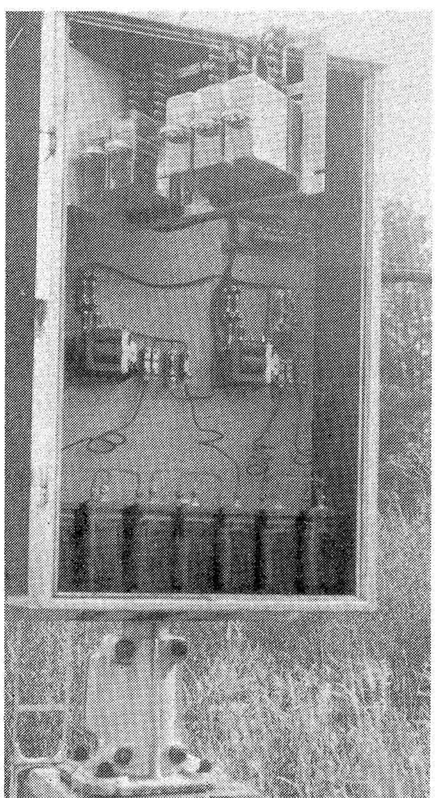
Loud-sounding electric horns are located at both ends of all sidings. By throwing the proper MC toggle switch and pushing the codestarting button, the dispatcher can send out controls to cause these horns to blow for two sec. and thus call signal maintainers, or track foremen, to the phone. Also, if a train is stopped on the main track or siding at such a location, enginemen or conductors are called to the phone by these horns. If the CTC code line fails, this is detected in the maintainer's quarters on the far side of the break from the control machine.

Track Circuits Feed East or West

The track circuits in each siding-to-siding block are the neutral, normally-energized type with a relay and a battery at both ends, so that they can be fed from either end. For example, to establish westward traffic direction in the siding-to-siding block between Dishnish and Minnipuka, the dispatcher throws signal lever 839 and presses the code-sending button. A part of the preliminary action is that a control goes to the east end of Minnipuka which causes track battery to feed eastward, in cascade, through all the nine track circuits to the west end of Dishnish. Thus the track circuits feed in the direction opposite to the next train movement. This track circuit control, in combination with codes sent to Dishnish, cause westward signal 839 to clear. Thus in this system, no local signal line control circuits are required for the two-position siding-to-siding signals.

When a westbound train accepts and passes signal 839, the track circuits behind it remain de-energized until the rear of the train passes beyond signal 909 at Minnipuka then the track circuits are again automatically energized in cascade, west-to-east, all the way back to the west end of Dishnish, which would cause a corresponding "all unoccupied" indication to go to the control machine. If an eastbound train is to be run between Minnipuka and Dishnish, the code control sent out cuts off the west-to-east track circuit feed in the station-to-station block, and establishes east-to-west track circuit feed.

The relays used on these track circuits are the DN22B direct-current biased-neutral type, rated at 0.4 ohms. The pickup is at 0.16 volts, 0.32 amp., and the working values are the same as the pickup. The drop-away values are 0.128 volts, 0.256 amp. These relays have good shunting characteristic, and operate satisfactorily without wet track failures on circuits up to 5,200 ft. long on this CTC territory. The biased neutral feature provides protection against broken down insulation in insulated rail joints. The biased neutral relay has another feature: they are biased in one direction for the current of traffic in that direction, and in the opposing direction they are biased in the opposite direction. The correct polarity of the battery has to correspond in the direction which the traffic is set up for. Therefore, foreign current could not set up an unsafe condition.


Hinged rack swings out

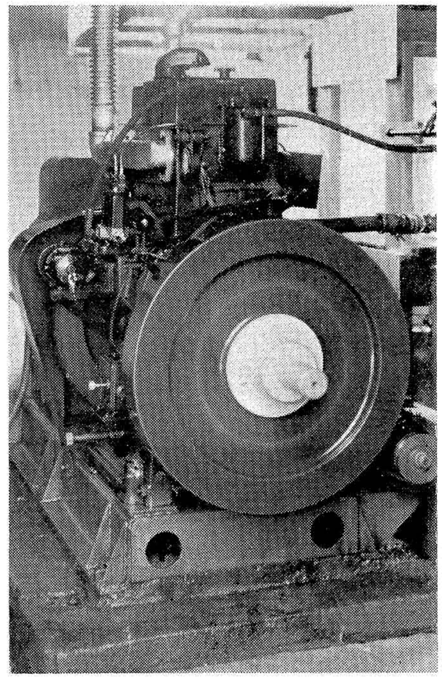
At each outlying hand-throw switch leading to a spur, there are additional insulated rail joints in the main track. The circuits through the switch circuit controlled are connected to open the track circuit and shunt it, when the switch is open. Normally, the track circuit is jumped around the insulated joints through the switch circuit controller.

On 10 mi. of this subdivision there is a test installation of bonding using short plug-type bonds from angle bar to web of rail at both ends of the bar. On the remainder of the territory, the bonds are the United States Steel Company type S5 strand bonds, which extend around the length of the bars, and have ⅜-in. pins in the web.

The approach signals, such as westbound signal 895, operate to three positions, to display yellow for a westward train if signal 909 is at Stop, or green if signal 909 is green, or red if track is occupied or traffic direction is eastward. The searchlight mechanism in approach signal is line controlled by a two-wire polarized line circuit.

Signals and Switches

The signals on this project are the Union H-2 plug-coupled searchlight type with 250-ohm coils for operation on 8 to 10 volts d.c. The signal lamps are continuously lighted for two reasons: (1) as some information concerning approaching trains, for benefit of men on motor cars, and (2) to give off a little heat as an aid in minimizing the formation of frost inside the mechanism case. These lamps are normally fed from transformers but are switched to feed from battery if the a.c. fails. As an aid in increasing the stand-by time from battery, lamps rated at only 5 watts are used in these signals.


Engine-driven generator

In order to place the leave-siding dwarf signals up above snow, as much as possible, the dwarfs on the field side of sidings are on masts that place the center of the lens about 4 ft. above the level of rail, and the dwarfs between the main track and siding are also at a level about 4 ft. above top of rail. Lead nuts are used on the anchor bolts on these dwarfs, with the hope (occasionally realized) that the signal—if hit by a snow plow—will go over easily, and without damage to the base casting or mechanism.

The switch machines are the Union style M-23-B dual control with 20-volt d.c. motor. The gear ratio is 528 to 1, and the operating time is about 15 sec. Electric heater units are located in the switch machine to minimize the formation of frost. One heater, rated at 15 watts, is located in the circuit controller compartment, and another heater, also rated at 15 watts, is in the motor compartment. These heaters are fed 110 volts a.c. and are energized throughout the winter season. The switch machines are painted aluminum. During changes in temperature below and above freezing, the aluminum reflects the sun's heat and thereby minimizes changes of temperature inside the switch machine. The searchlight signal cases are also painted aluminum for the same reason.

At each spring switch there is a Pettibone-Mulliken Company oil-buffer spring mechanism used in connection with a 31B, Ramapo-

Ajax hand-throw switch stand, which is attached by four ¾ in. bolts through the ties.

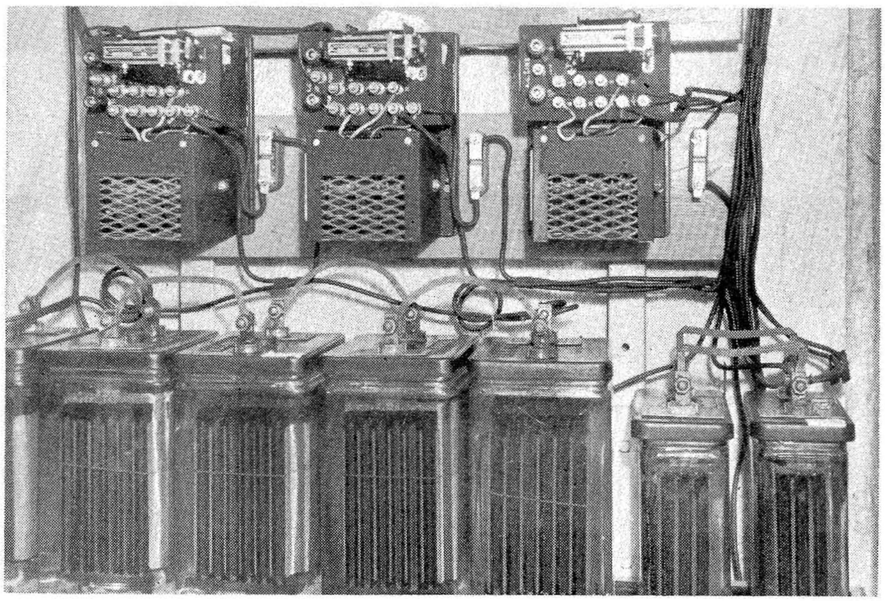
Plug-In Relays on Swing Racks

The relays on this project are the plug-in type, which can be changed out quickly without changing wiring connections. These relays in the outdoor sheet-metal cases, are on swing racks, which are hinged at one side to swing out, thus giving access to the rear. The wiring connections in the houses and cases are made with solderless terminals, made by the Aircraft-Marine Products Company.

The old pole line used for communications line circuits in this territory was in bad condition. Therefore, before installing the new signaling, this pole line was completely rebuilt, using 20-ft. creosoted pine poles 40 to the mile. The telegraph and telephone wires are on the upper crossarm and the signaling wires on the lower. The two line wires for the CTC code are No. 9 bare hard-drawn copper. The two wires for the 550-volt a.c. power distribution are No. 6 copper with neoprene covering. The two-wire line circuits from each end of the siding out to the approach signal are No. 10 Copperweld with Neoprene covering.

Commercial a.c. power feeds east from Hornepayne for 20 mi. and west from Foleyet 19 miles to Missonga. No commercial sources of a.c. power are available in the 109 mi. between Penhurst and Missonga; therefore, diesel engine generator sets were installed at Fire River, Oba and Elsas. These sets were furnished by the Russell Hipwell Engines Limited of Owen Sound, Ont., and use an alternator made by Electric Machinery Manufacturing Company, Minneapolis, Minn., using 13.5-h.p. diesel engines built by the R. A. Lister Company, Dursley, England. The alternator is rated at 9.4 kva., 115 volts, 32 amp. These engine-alternators are in duplicate at each of the three power stations. One set or the other is in operation all the time at each station. Power stepped up to 550 volts feeds in both directions for about 18 miles from each station. Filters are used in alternator circuits to prevent "ripple" getting to the line that might affect the communication circuits. At each siding, a capacitor, rated at 10 m.f., is connected to the 550-volt power line circuit, as a means of improving the power factor.

The 550 115-volt line transformers at power switch locations are rated at 250 v.a.; at intermediate signals, 50 v.a.; and at track cuts, 25 v.a. These are Canadian General Electric, air-cooled, crossarm mounted transformers.



Rectifiers and battery in concrete house at power switch location

At each power switch a set of 13 cells of 120-a.h. lead storage battery feeds the switch machine motor and the line code equipment. Each track circuit is fed by an 80-a.h. lead storage cell. These batteries are made by the Hart Battery Company, St. John's, Que.

Constructed by Railroad Forces

This centralized traffic control project was planned and constructed by Canadian National signal forces. Field headquarters were at Hornepayne. At each power switch location, there is a monolithic reinforced concrete house 9 ft. by 16 ft., with an 8-ft. ceiling. Each house has a room 7 ft. by 8 ft. for relays, coding equipment and batteries. A second room 7 ft. by 8 ft., including a coal-burning stove, is used as a telephone booth and as a warming room for track forces, and signal maintainers. These houses were made in Hornepayne and were set in place by a power derrick.

Sectionalized concrete signal foundations were made and assembled at Hornepayne. The signal masts, with ladders were also assembled at Hornepayne. Sheet-metal instrument cases used at intermediate signals and at cut sections were manufactured and wired complete in railway shops in Montreal. Likewise, relay racks for the concrete houses were wired at Montreal and installed in the houses at Hornepayne.

These concrete houses, signal foundations, masts, and cases were loaded on cars and run in a work train, including a clam-shell and a power derrick. The clam-shell was used to dig holes for the signal foundations. Then the derrick was used to set the houses, signal foundations and relay cases. The remainder of the materials: wire, cable, batteries, relays, etc., were hauled out on motor cars.

In the autumn of 1950 rail bonds were installed on about 20 miles of track before snow. During the winter, some work was done in the shop at Montreal and indoors at Hornepayne. Starting in April, 1951, outdoor construction was begun, and the entire 148-mi. project was completed on December 14, 1951. During the final six weeks, all the signalmen available, including inspectors, draftsmen and supervisory forces, worked long hours every day, including Saturdays and Sundays, to complete the installation, in spite of 20 deg. below zero weather, snow and shortages of material. The objective having been realized, placing all the CTC in service before severe weather was a great aid to train operations during the winter months.

This project was planned and installed by Canadian National forces under the jurisdiction of H. L. Black, system signal engineer, with headquarters at Montreal, and under the direction of E. P. Stephenson, signal engineer, Central Region, at Toronto. N. W. Mountain, superintendent of signals of the Northern Ontario District, had charge of field construction forces. The major items of signaling equipment were furnished by the Union Switch & Signal-Division of the Westinghouse Air Brake Company.