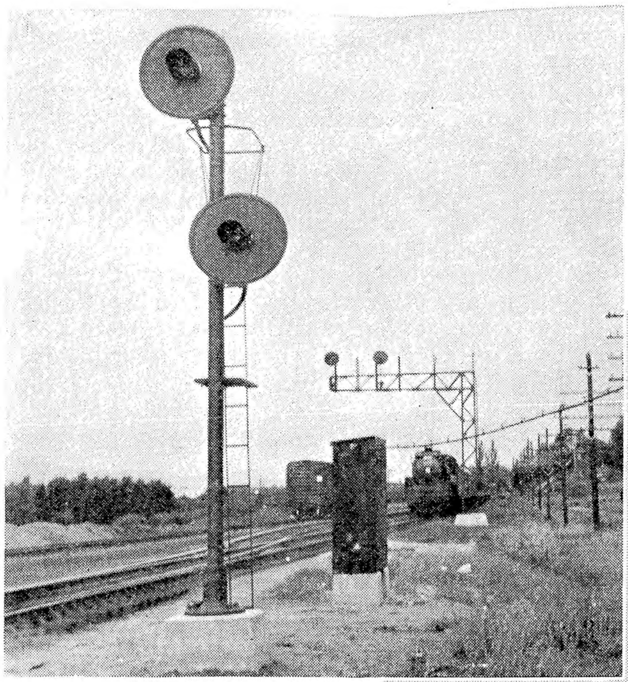
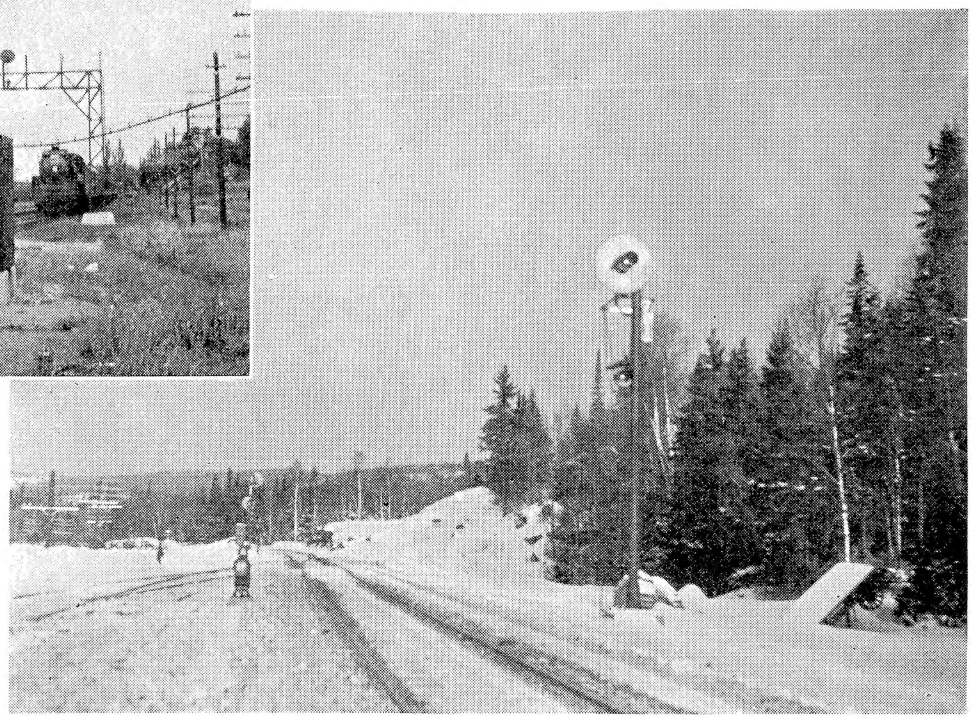
Canadian Pacific





The westward signal at the east end of yard at White River
Right — Typical signal layout at the end of passing track

Safety improved and operations are expedited by reducing spacing between following trains

As a means of improving safety and reducing train delays, the Canadian Pacific has installed automatic block signals on 250 miles of single-track between Chapleau and Schreiber, Ont., which is a part of the through route between Montreal, Que., and Vancouver, B.C., Chapleau, the east end of the project, being 608 miles west of Montreal. The newly signaled territory includes two sub-divisions, the White River sub-division between Chapleau and White River, 129.9 miles, and the Heron Bay sub-division between White River and Schreiber, 118.3 miles. The entire 250 miles of automatic block signaling between Chapleau and Schreiber is the longest single installation of its kind which has been completed in North America for many years.

As shown in the accompanying sketch, the line from Montreal west through North Bay is joined at Sudbury with a line from Toronto. Thus traffic to and from Montreal and points east, as well as to and from Toronto and southern Ontario points, all converges at Sudbury. Double track extends from Sudbury to Cartier, 34 miles. All this traffic in both directions is handled over one single-track line west from Cartier to Ft. William. Of the entire 518 miles between Cartier and Ft. William, signals were needed more from the standpoint of safety on the two sub-divisions between Chapleau and Schreiber, not only because there are scheduled meets between eastbound and westbound passenger trains in this territory, but also because of the numerous curves, hills, rock cliffs and tunnels which result in short sighting distances. Between Chapleau and Heron Bay, 185 miles, the line cuts across country through territory most of which is of glacial formation. Between Heron Bay and Schreiber, the line in general follows along the north of Lake Superior, passing through rough glacier formation, most of which is barren rock. The grades throughout the two sub-divisions are rolling. On the White River sub-division the ruling grade eastbound, about 4.5 miles long between M.P. 36 and 40.5, has a maximum of 1 per cent. The ruling grade westbound is about 4.2 miles long between Grassett and Ryerson, the maximum being 1.6 per cent. On the Heron Bay sub-division the ruling grade westbound is 3 miles long between Coldwell and Neys, the maximum being 1.1 per cent. The ruling grade eastbound is about three miles long between M.P. 81 and Neys, the maximum being 1.3 per cent. The curves are very numerous to the extent that sections of tangent more than a mile in length are very rare, the maximum curvature is 8.0 deg., but for the most part the curvature does not exceed 6 deg.

Traffic Increased to 30 Trains Daily

The schedules include three passenger trains each way daily. The second class trains include an eastbound stock train and two west-

Installs Automatic Block Signaling

On 250 Miles of Busy Single Track

bound fast freight trains daily. The eastbound freights are handled as fourth class trains, the schedules including five such trains daily. Thus the schedules include six passenger and eight freight trains daily, totaling 14 trains, but the heavy traffic for the last three years has required extra trains so that a total of about 30 trains have been operated daily.

Track and Signal Layouts

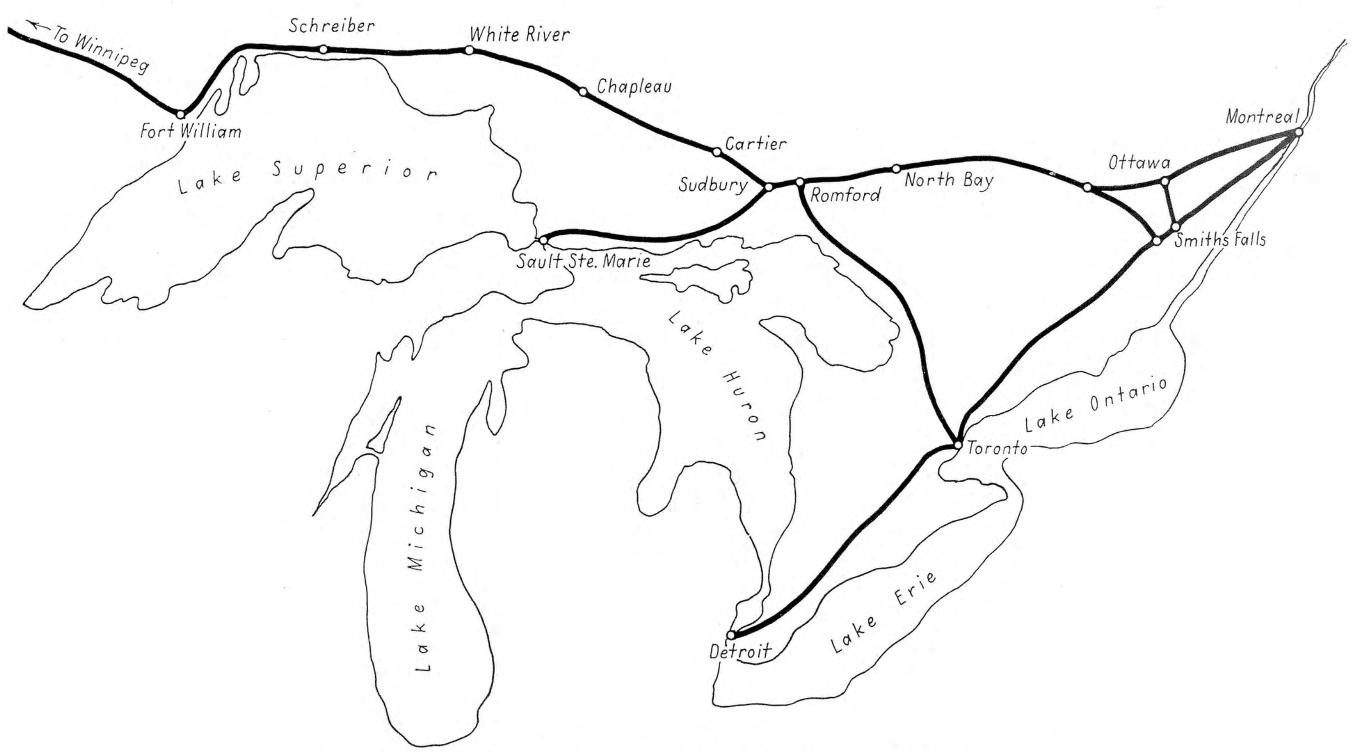
The main track is single throughout this project. On the 129.9 miles between Chapleau and White River, there are 24 passing tracks, and on the 118.3 miles between White River and Schreiber there are 22 passing tracks. The names and the car capacities of the passing tracks are shown on the accompanying plan. The turnouts at the ends of these passing tracks are No. 11, and the switches are operated by hand-throw stands.

An interesting feature of this project is the special arrangement of signals at the ends of the passing track as shown in detail in the sketch herewith applying to Esher, which is typical of all the layouts. The two entering signals, 83 and 90, each have two operative "arms" each consisting of a searchlight mechanism. The upper signal unit is mounted to the left of the mast and the lower is to the right, the vertical distance between the centers of the lenses being 5 ft. The upper "arm" which governs over the "straight" track route, displays three aspects, red, yellow or green, over a red in the lower "unit." The lower unit normally displays red, but when the switch is reversed by operation of the hand-throw stand, then the signal, such as 83, displays an aspect of red-over-yellow.

The main track leaving signals, such as 84 and 89, are Absolute signals, being equipped with a lunar white marker unit which is mounted on the mast 5 ft. below the center of the lens of the main signal unit. This marker is lighted in combination with any aspect in the main unit.

Signal Opposite Clearance

A point of importance is that these main track absolute leaving signals are located opposite the clearance point on the turnouts, thus being "short" of the switches, so that, for example, an eastbound train which is to hold the main line for a meet, can, with safety, pull on down and stop short of signal 84, while the westbound train is arriving and entering the passing track. If the meet is "close," the chances are that the eastbound train may not have to stop, whereas with the conventional arrangement, including a double location of two signals on the single track in approach to the facing point of the switch, the eastbound train

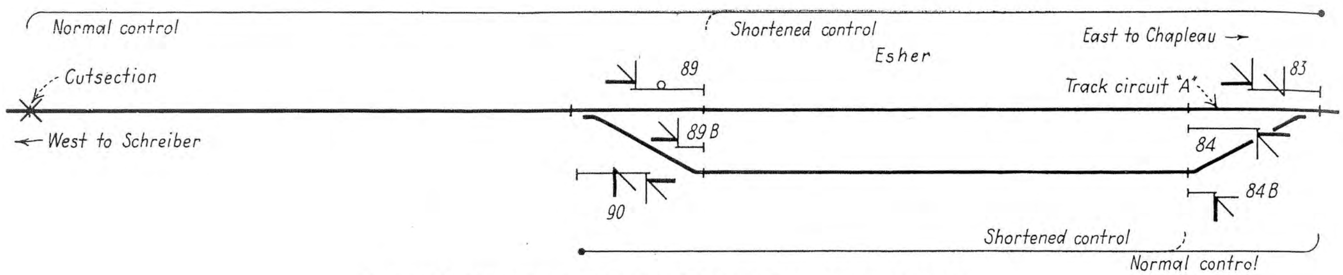


Map showing in general the location of a portion of the Canadian Pacific

probably would have been stopped at the entering signal at the other end of the passing track.

Leave-Siding Signals

Another unusual feature of this project as automatic signaling, is the provision of leave-siding signals. These are dwarfs which normally display the red aspect. When the



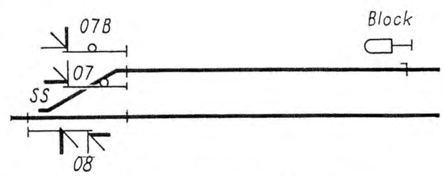
Typical signaling arrangement showing limits of controls

switch is operated by the hand-throw stand for a train to depart from the siding, then the circuits through the switch-position repeater relays are changed so that leave-siding dwarf 84B, for example, takes over the control formerly applying to the station-leaving main-track signal 84. Then the Stop aspect is displayed on signal 84 and the proceed aspect, either yellow or green, is displayed on the leave-siding dwarf 84B. The aspect would be yellow if the train ahead had cleared only one automatic block, or green if the train ahead had cleared two or more blocks.

Thus the signals at the ends of the passing tracks are to be used most effectively to improve protection and save train time in the present automatic block system, and furthermore the signals, as now installed, are in the proper locations to be used as semi-automatic signals if the system is later converted to centralized traffic control.

Overlap of Entering Signals

Referring to the plan of the layout at Esher, in order to prevent an occasion in which opposing trains might simultaneously accept proceed aspects and pass main track signal 83 and 90, the line control of westbound signal 83 is overlapped so that



Signals at spring switch layout

it will display the red aspect when an eastbound train passes the cut section at "X." The control of eastbound signal 90 extends only to signal 83. The overlap is to the east of the siding because eastbound trains are superior by direction, and, therefore, the westbound train is the one that ordinarily would take siding for a meet.

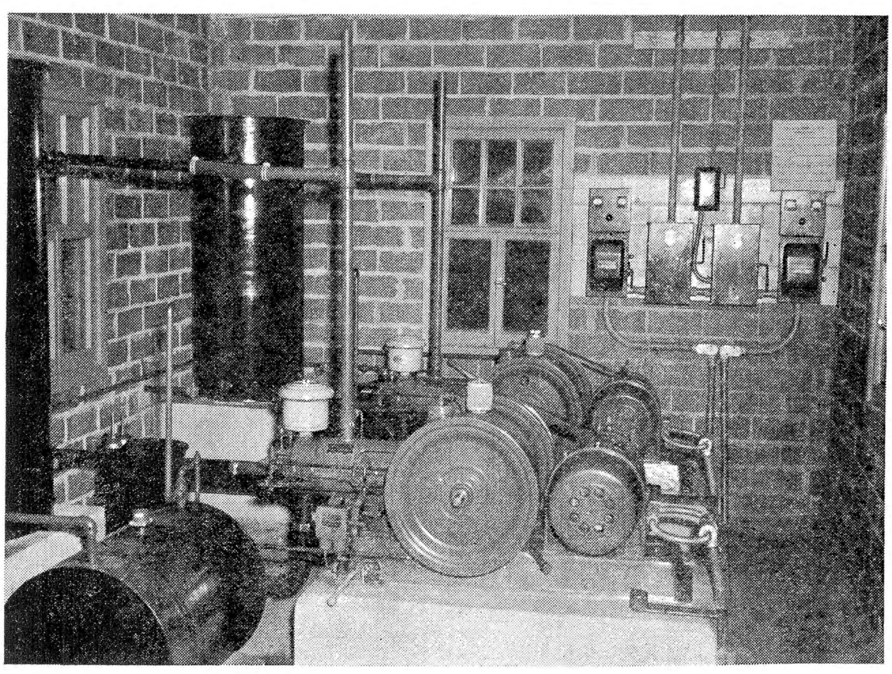
When a westbound train arrives, and stops short of signal 83, as soon as the head brakeman throws the switch, the line control of eastbound signal 90 is shortened from the insulated joints at signal 83 to the joints at signal 84; in other words, the switch turnout detector track circuit is excluded. This is the feature which allows the signal 90 to display a yellow aspect to direct the eastbound train to pull on down to signal 84.

This shortening of the control of signal 90, when the switch at the east end is reversed, is accomplished running the control of signal 90 through contacts of the switch repeater relays. Contacts in the switch circuit controller are connected to circuits which operate two 500-ohm switch-repeater relays, one of which is energized to repeat the normal position of the switch, and the other is energized to repeat the reverse position of the switch. With the reverse switch repeater relay energized, the line control of signal 90 goes to battery without including a contact in the relay for the track circuits A between signals 83 and 84.

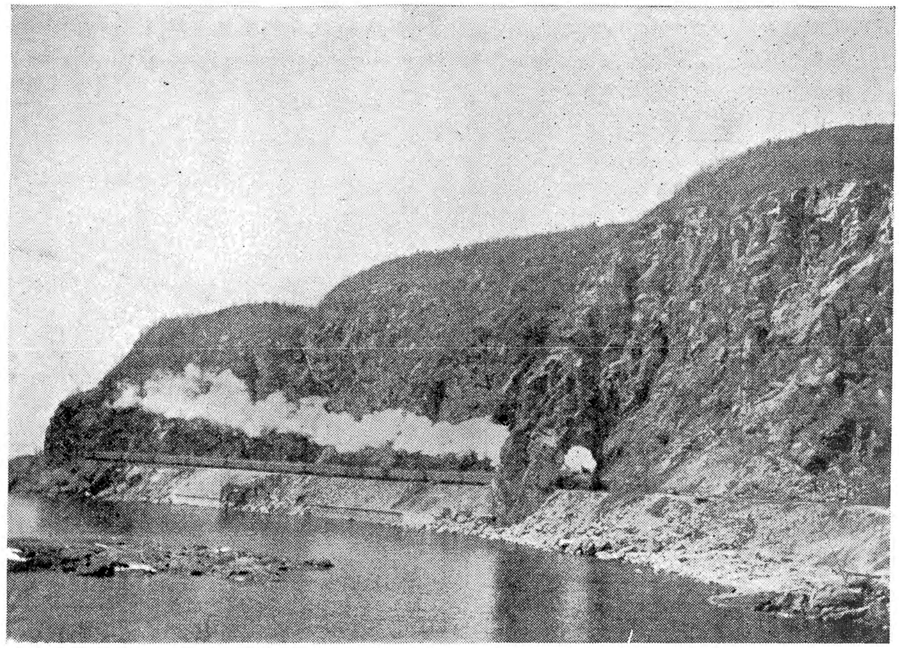
After the switch is reversed and the westbound train enters track circuit A, then the reverse switch-repeater relay is stuck up through a back contact of the relay for track circuit A. The purpose for this stick circuit is to prevent changing the aspect of signal 90 from yellow to red if the east switch is placed normal before the rear of the westbound train clears the A track to get in the clear on the siding.

Signals at Spring Switch

A spring switch mechanism with a mechanical facing-point lock is in service at the switch which connects



One of the duplicate sets each consisting of a 5-kva. a-c. generator, belt connected to a 6-h.p. Diesel engine



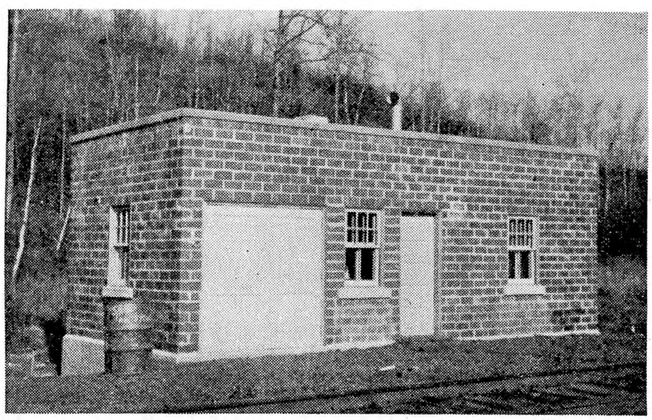
On the shore of Lake Superior the track is about 70 ft. above the water and along high rock cliffs — The view shows eastbound train with locomotive passing through a tunnel

the yard lead with the main line at the west end of Chapleau, so that westbound trains departing from the yard can trail out through this switch without stopping.

The westbound main track absolute signal O7, normally displays the green aspect, and the dwarf O7B on the yard lead displays the red aspect.

Until a westbound train is ready to depart, it must not pass the "Block" sign, which is at the east end of a track circuit 800 ft. long on the yard lead from this sign to dwarf signal O7B.

When the locomotive passes the "Block" sign, thus shunting the track circuit, if no westbound train is approaching on the main track, then the main track signal O7 is set at the Stop aspect, and then the dwarf signal O7B takes over the controls formerly applying to the main-track signal O7. A time-element relay has been provided to introduce 20 seconds delay, if a westbound train should be about to occupy the approach track circuit to signal O7, thereby allowing the main-track train to hold signal O7.



Typical building to house an engine - generator set and the maintainer's motor car

Intermediate Automatic Signals

Where the distance between passing tracks is short, as for example about 4 miles between Esher and Pardee, one set of staggered intermediate signals are provided, the distance between opposing intermediates being a minimum of 1,500 ft. In the majority of instances, the distance between passing tracks is comparatively short, i.e., 3 to 4 miles plus or minus. Therefore, on the entire project there are a total of 28 layouts where there are only one set of staggered intermediate signals between sidings.

Where the distance between passing tracks ranged from about 5 to 6 miles, as for example 5 miles between Lochalsh and Pick, two double locations of intermediate signals were installed. Where the distance between passing tracks ranged from 6 miles up to a maximum of 7.8 miles, the number of intermediates was determined on a time-distance basis of train operation. For example, on 6.6 miles of comparatively "fast track" between Amyot and Tripoli, only two sets of double intermediate were installed. However, on 6.4 miles of curves and grades between Swanson and Franz, there are three sets of double intermediates.

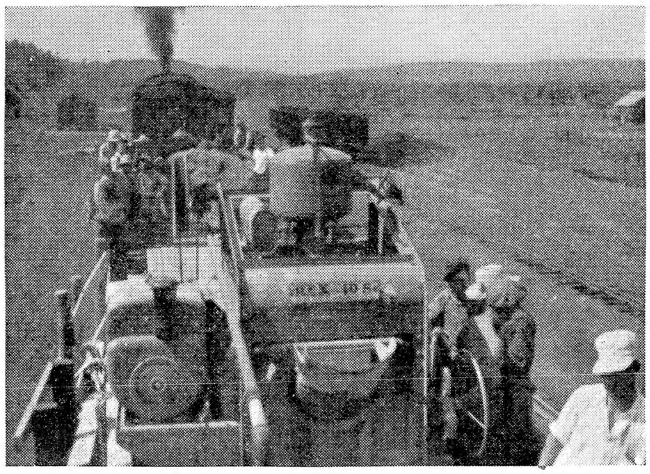
Thus it is evident that the intermediate automatic blocks were planned to provide for comparatively close spacing between following trains, and the reasons for this will be evident later in the discussion of the methods of train operation.

Methods for Authorizing Train Movements

Train movements are authorized by timetable and train orders, this practice being the same now as it was before the automatic block signaling was installed. On account of local conditions and other factors, it is now, and for many years has been impracticable to maintain open train order offices at all or any major percentage of the passing tracks on these sub-divisions. One cause for train delays was the inability to operate following trains on close headway with safety. In order to handle the wartime traffic, the regular practice is to operate two or more sections of several of the scheduled trains. If the following sections of a train were spaced the distance between open offices, the traffic could not be handled. A practice followed previous to the installation of the automatic signals was for trains to keep at least 10 minutes apart, except when closing up at stations; and passenger trains as well as freight trains following a passenger train were blocked 20 minutes by the open telegraph offices.

Spacing of Trains

Primarily for these reasons, the intermediate signals were arranged to provide the minimum safe spacing between following trains, and also to give the enginemen confidence, when clear aspects are displayed, to proceed at maximum permissible speed, thereby freeing the



The foundations were poured in place using the power mixer on a flat car in the work train

sections of tracks between sidings more quickly to be used by other opposing trains.

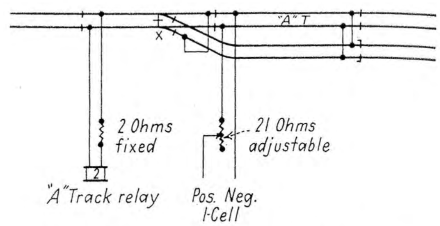
In so far as improving the safety of train operation, and of expediting following movements are concerned, the automatic block signaling has accomplished the results for which it was planned. The accomplishment of these results by installing automatic signaling on the entire 250 miles between Chapleau and Schreiber, at the earliest possible time, was considered to be more desirable than installing centralized traffic control, between Chapleau and White River, because it was decided, in February, 1943, that automatic signaling could be installed within a year on the 250 miles as a whole, whereas if centralized traffic control had been included in the original project, the construction for the 1943 season would have been limited to about half of the territory, i.e., one sub-division. With the signals located as has been explained, and with the power supply available as will be discussed later, the C.T.C. can be added at a minimum cost at a later date.

A.P.B. Control Circuits

This automatic block signaling is controlled by the conventional absolute-permissive block system of circuits which control the leaving absolute signals to prevent opposing train movements between any two sidings, but the intermediate signals are controlled by directional-stick relays in the usual manner to clear signals for following train movements in a siding-to-siding block.

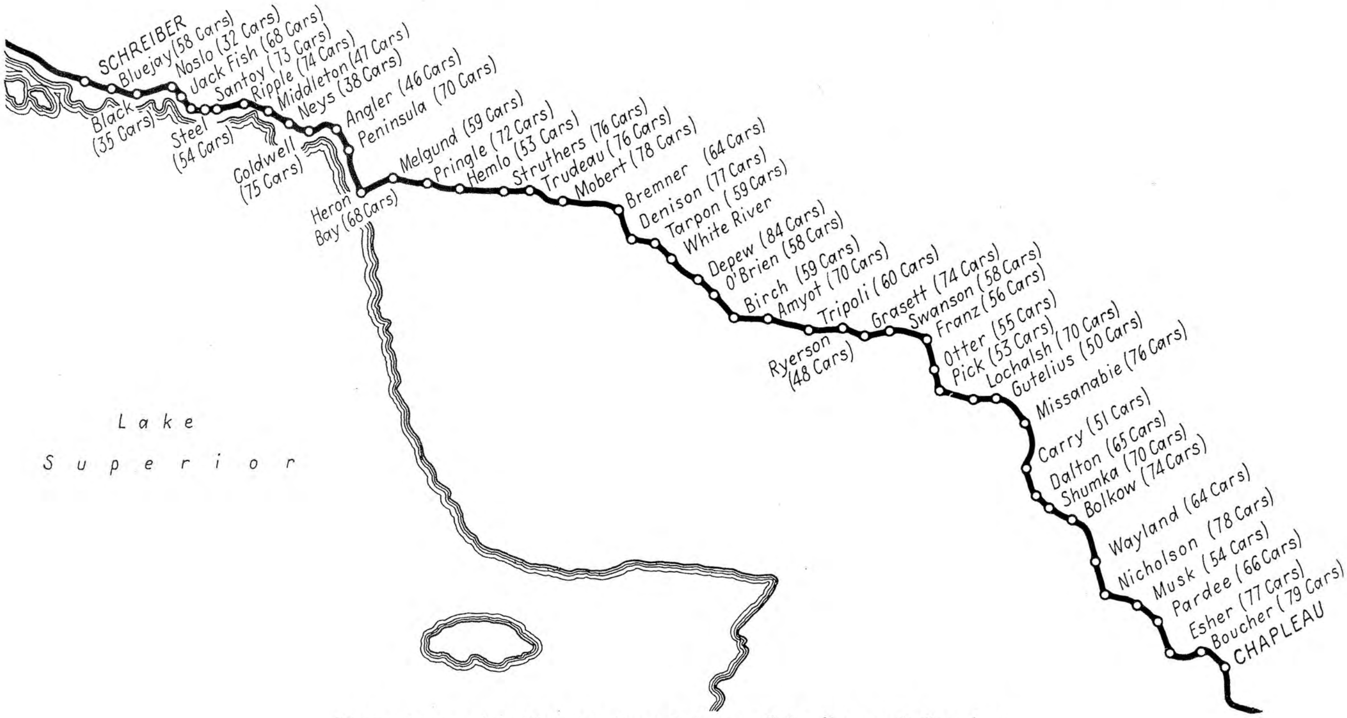
The operating coils of the searchlight signals are rated at 250 ohms for operation on direct current. These coils are directly connected to the polarized line control circuits, thus eliminating line relays. Each line circuit consists of two line wires, which extend double-make, double-break through contacts of the neutral track relays, and connections are made to shunt the line toward the signal when a track relay is de-energized.

The position of each searchlight signal is repeated by a 400-ohm d-c. slow-release relay which is energized when the signal is in either the yellow or green position. The feed to a line circuit to the rear is polarized through contacts of the yellow-green repeater relay of the signal ahead, thus avoiding undesirable flashes of a signal. The directional-stick relays at the intermediate signals are the d-c. neutral type rated at 250 ohms and are slow-release.

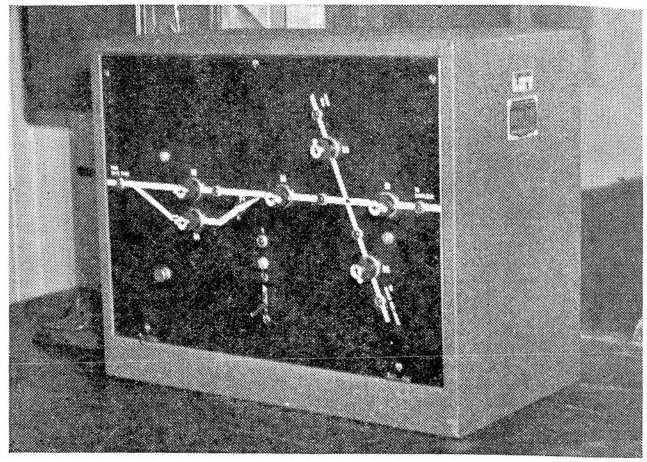


Series fouling circuit at a turnout

The track relays are the d-c. neutral type rated at 2 ohms, and the track circuits range in length up to a maximum of 5,000 ft. The rail joints are bonded with plug-type bonds made by the American Steel



Map of new signaling territory between Schreiber and Chapleau

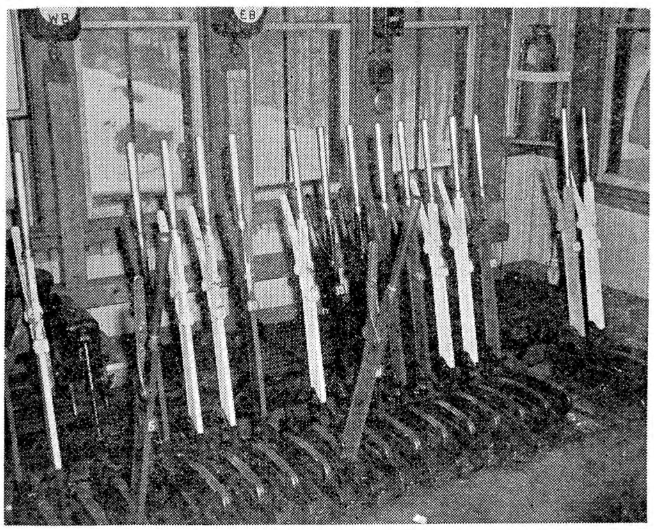


The new panel-type interlocking control machine constructed at Franz

& Wire Company. A series-connected track circuit is used at each passing track turnout, as shown in one of the accompanying drawings. An advantage of this form of circuit is that if any wire connection or bond fails, the circuit fails on the safe side. The circuit is quick shunting, an advantage in a switch detector circuit if C.T.C. is installed.

The track and line circuits are normally energized to control the searchlight signals to the green position, this statement applying with the exception of the leave-siding dwarfs and the lower "arm" of the entering signals, the controls for which are through contacts of switch repeater relays, as previously stated.

The lamps in the signals are normally extinguished, except in the leave-siding dwarfs which are normally lighted. The approach lighting controls are through back contacts of track relays where available. When there is no track relay at the signal, a 60-ohm approach lighting relay is connected in series with a line circuit. The lamps in main track absolute leaving signals are lighted whenever that signal is controlled to the Stop aspect, this lamp circuit being through back contacts of the yellow-green repeater relay. With this practice, a train at one siding or a man on a motor car thus gets information when an opposing train leaves the next passing track.



The old mechanical machine which was removed at the Franz layout

The signal lamps are of the single-filament type, rated at 11 watts at 10 volts. At the passing tracks, the lamps are normally fed from a transformer-relay, but in case of a failure of the a-c. supply, this relay is released to switch the lamp load to the battery. At intermediate signals the lamps are lighted from the battery.

The lamps formerly used on switch stands were removed from all switches located within 200 ft. of a signal which is protecting the B switch involved. Removal of the switch lamps not only obviates the maintenance of these lamps, but also improves safety by eliminating confusion between a switch lamp and a signal, as viewed by the enginemen.

Special System of Power Supply

The track circuits and signal control circuits operate from storage batteries which are on floating charge from rectifiers that are supplied through transformers from an a-c. signal power distribution line. A limited amount of a-c. power was obtainable at Chapleau and at Schreiber, otherwise no a-c. power was available at any intermediate location except from a high-tension line at Lochalsh, as will be discussed later.

Alternating current at 575 volts single-phase from a connection at Chapleau feeds west 13.4 miles to Pardee. At Lochalsh, 68 miles west of Chapleau, power was obtained at 4,600 volts a-c. from the Great Lakes Power Company. A signal power circuit at 4,600 volts single-phase was constructed from Missanabie eastward for 30.4 miles to Wayland, and from this 4,600 volts, a 575-volt single-phase line feeds east from Wayland to Pardee, 14.1 miles. Thus with the 575-volt feed from Chapleau to Pardee, and from Wayland to Pardee, the power circuit, as well as the four signal line control wires, were placed on a new crossarm on the existing pole line.

On the 72 miles westward from Missanabie to White River, a three-phase 4,600 volt signal power line, using three wires, was installed. On this 72 miles, as well as on the 30.4 miles eastward from Missanabie to Wayland, a new pole line was constructed on the north side of the tracks. This was the only new pole line built; on all the remainder of the 250 miles the a-c. signal power distribution is at 575 volts single-phase, and this circuit as well as the signal line control circuits are on a new crossarm on the previously existing communications pole line.

The 4,600-volt power line also feeds a coaling station and an electric pump at Missanabie, as well as electric pumps at Franz and at Amyot. The three pumps, which furnish water for locomotives, were formerly operated by steam.

At White River, power from Lochalsh is transformed to 575 volts single-phase and fed westward 22.3 miles to Mobert, this being the end of the a-c. power from the 4,600 volt line. From a local source at Schreiber, 575 volts single-phase is fed eastward from Schreiber to Black, 11 miles.

Small Diesel-Generator Sets

For the territory west of Mobert to Black, the 575-volt single-phase a-c. signal power distribution line is fed from three stations, Helmo, Coldwell, and Jack Fish, which also are maintainers' headquarters. At each of these locations, there are duplicate sets, each consisting of a 110-volt 5-kva. generator, belt-connected to a 6-h.p. Diesel engine. Each station feeds the line for about 15 miles in each direction. One of the engine-generator sets at each station is operated continuously. If one set fails, the other can be placed in service. The signals continue to operate as usual, even if the engine-generator stops. The signal batteries have capacities to operate the signaling for at least two days.

The engine-generators are housed in new fire-proof buildings made of "Speed Tile" blocks, the buildings being large enough to serve also as tool houses for the maintainers.

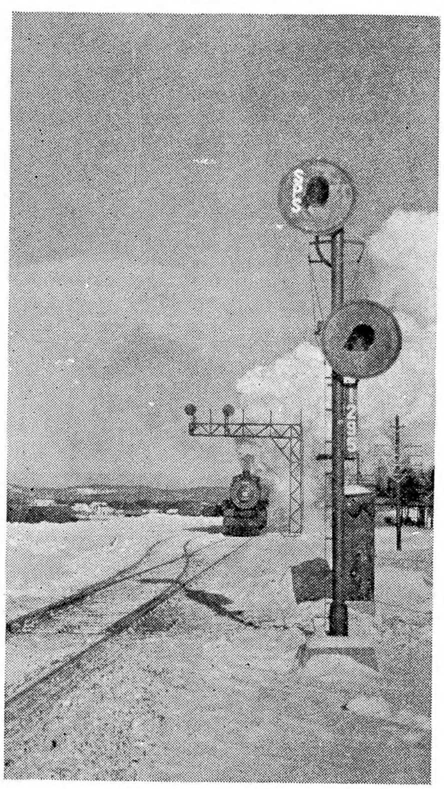
Line Wire Materials

The four signal line control wires throughout the project are No. 10 Copperweld with weatherproof covering. The two wires for the 575-volt single-phase power circuit, where used, are No. 6 copper with weatherproof covering. The wires for the 4,600-volt line are No. 6 bare copper. The insulators for the 4,600-volt line are Ohio Brass No. 12847, pin-type porcelain, and for the 575-volt line, the No. 29207 pin type. Double petticoat glass insulators are used on the signal line circuits.

Local Line Transformers, Rectifiers and Batteries

On the sections fed from the 575-volt line, at the intermediate signals the 575/110-volt line transformers are rated at 100 VA, and at the head-block locations at 500 VA, thus providing ample capacity for C.T.C. coding. On the 4,600-volt line, a 750 VA, 4,600/110-volt transformer is used at all locations. The rectifiers to charge the batteries are connected to the 110-volt circuit.

At each intermediate signal location there is a set of 5 cells of Exide KXHS-7 storage batteries, and at the signals at the ends of the passing tracks, 5 cells of KXHS-13. Each track circuit is fed by one cell of KXHS-13.



Eastbound transcontinental passenger train, The Dominion, near the signal at the east switch of White River yard

Field Construction

The concrete signal foundations were poured in place from a mixer on a flat car in a work train. This mixer, which was driven by a gasoline engine, had a capacity to mix 10 cu. ft. With a force of 8 men, the two foundations at a double location could be poured in about 25 minutes, on the average.

In the material yard at White River, the signal masts with base castings, ladders, ladder platforms and searchlight cases, were assembled complete. These were loaded on flat cars or in gondolas, and, by the use of power cranes, were picked up and set in place on the foundations.

The instrument and battery cases were wired complete at the construction headquarters in White River. Sheet-metal cases were used at the intermediate signals, but large-sized wooden cases were used at ends of the passing tracks. These cases are equipped with inner doors as a means for excluding snow.

As shown in one of the illustrations, the relays, rectifiers, low-voltage transformers and arresters in these cases are mounted on a back-board of wood. The wires from the various terminals each pass through individual holes to a wiring space about 6 in. deep behind the board. Also the parkway cables are brought up into this space. Access to this wiring space is gained by removing a panel at the rear of the case.

One Interlocking Replaced

The only interlocking on this entire 250 miles of line is at Franz, where there is a crossing at grade with the Algoma Central & Hudson Bay. As a part of the new signaling program, the old 20-lever mechanical interlocking at this crossing was replaced by an electric all-relay interlocking which is controlled by a small panel-type machine on the operator's desk. This interlocking includes an electric switch machine on the east end of the passing track on the Canadian Pacific west of the crossing.

This signaling installation was planned and installed by the railroad forces under the direction of E. S. Taylor, signal engineer of Eastern Lines. The new pole line construction between Wayland and White River, 102 miles, as well as the installation of additional crossarms on the pole line on the remainder of the territory and the installation of all line wires, was handled by the forces of the Communications Department of the Canadian Pacific under the direction of R. R. Bacon, superintendent at Sudbury.

The field construction forces of the signal department were under the direction of A. J. Kidd, assistant signal engineer, with L. H. Hawkins, from the Western Lines as general signal foreman on the Heron Bay sub-division, and C. W. Laking from the New Brunswick district as general signal foreman on the White River sub-division.

Construction forces were housed in new boarding cars complete with kitchen, dining, and sleeping cars. A rebuilt parlor car, including an office and sleeping accommodations for seven men, as well as a shower bath, was used as headquarters.

Construction was started in a limited manner at White River on April 12, 1943. On account of the shortage of trained signalmen, as well as men to do any kind of work, the construction program was seriously hampered. Nevertheless the first section at Chapleau was placed in service on September 13, and 22 miles on the Heron Bay sub-division between White River and Mobert on October 21. The remainder of this sub-division was in service by December 11, and the 48.5 miles between Franz and White River on the White River sub-division on December 20. This made a total of 170 miles in service at the close of 1943. The signaling on the remaining 80 miles between Chapleau and Franz was completed and placed in service on March 8, 1944. The signaling equipment installed on the territory between Chapleau and White River was furnished by the Union Switch & Signal Company, and that installed between White River and Schreiber was furnished by the General Railway Signal Company.