# Soo Line Completes Signaling *on 260 Miles of Single Track*

**Modern arrangement of signals at sidings; special protection at spring switches; call-on aspect in automatic block prevents unnecessary train delays**

AUTOMATIC block signaling has recently been completed on 78 miles between Waukesha, Wis., and Wheeling, Ill., on the Wisconsin Central, operated by the Minneapolis, St. Paul & Sault Ste. Marie. This project connects with the 192 miles between Waukesha and Spencer, Wis., signaled in 1949, thus making a total of 260 miles. Two or more main tracks extend north from Chicago 29 miles to Wheeling. The new signaling between Wheeling and Spencer includes the major portion of the Soo Line route between Chicago and Minneapolis. This route extends on west through to points in Dakota, Montana and Manitoba, where connections are made with the Canadian Pacific to Vancouver, B.C., and other Pacific ports.

Spencer is a junction with a line north to Ashland, Wis., on Lake Superior, and Owen, 19 miles west of Spencer, is a junction with a line north to Duluth, Minn., an important port at the west end of Lake Superior. Thus traffic, to and from the three lines, is concentrated on the one route between Spencer and Chicago, which is the reason that this 260 miles was selected for the first extensive signaling on the Soo Line System.

### Sidings Lengthened

Throughout this territory, within the last few years, a number of sidings have been lengthened to hold trains of 100 to 125 cars. New No. 15 turnouts were installed at most of the ends of these sidings. In addition to automatic block, the signaling on the 260 miles includes remotely controlled power switches and signals at 8 ends of sidings, and spring switch at 31 ends of sidings. In this territory the railroad traverses rolling country with comparatively light grades and curvature, which can be negotiated at normal speeds by the through freight trains, all of which are now operated by diesel-electric locomotives. The track and roadbed are in good condition, thus contributing to the operation of trains at a uniform speed which averages rather high for a single track line.

The daily traffic includes 4 passenger trains and 8 to 12 through freight trains, with a few locals. The assign-

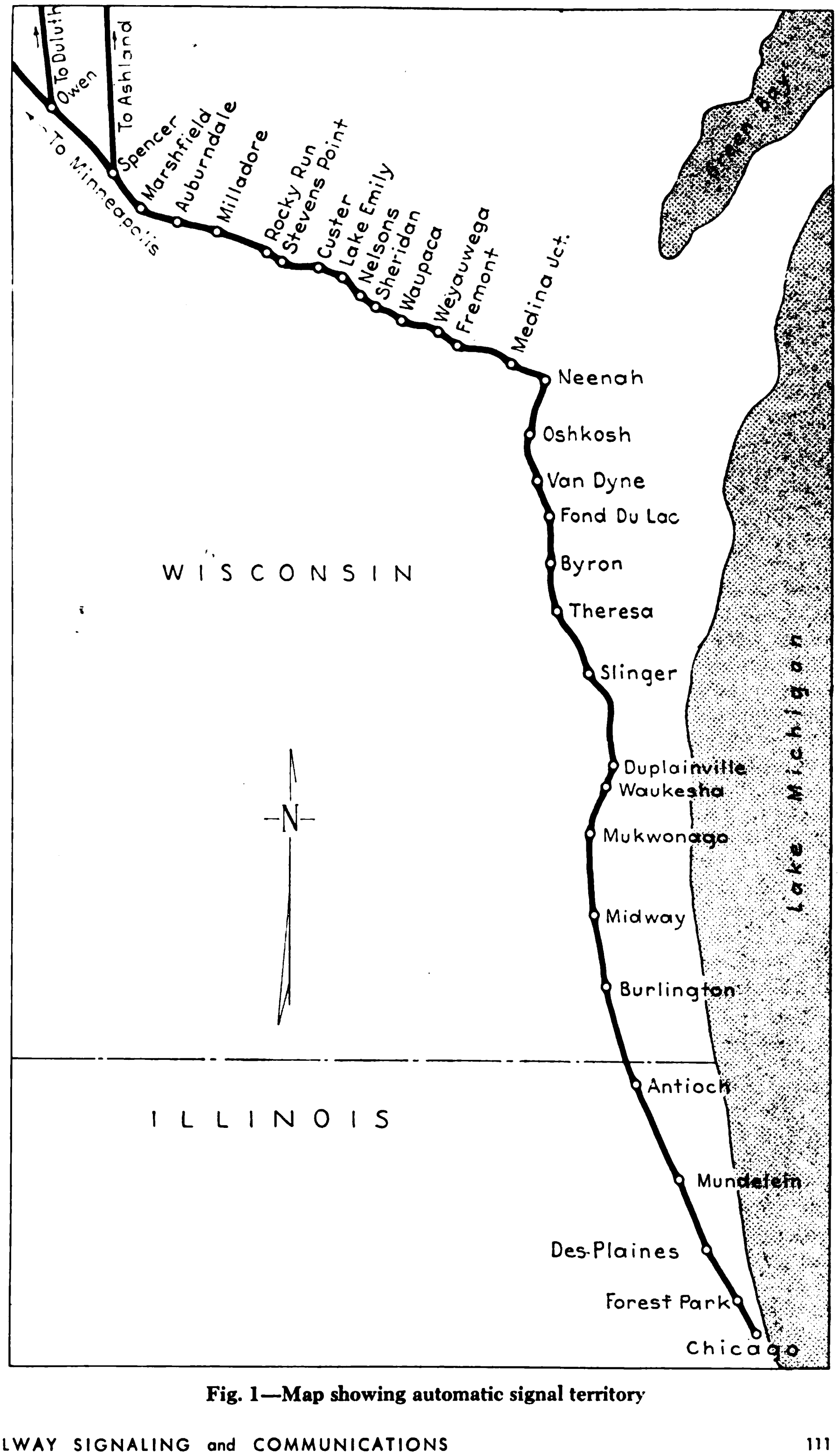
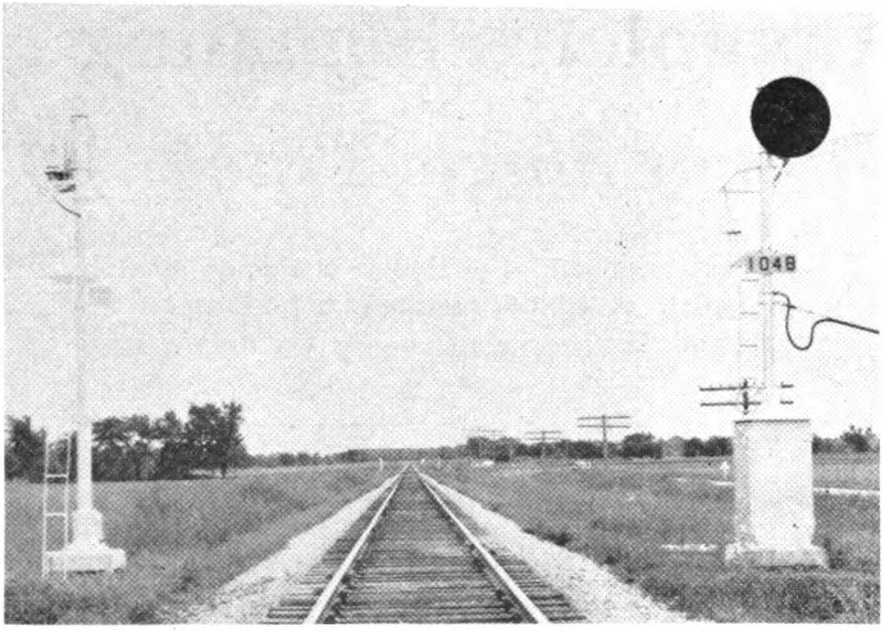



Fig. 1—Map showing automatic signal territory




Signals are the searchlight type

ment to the Supt. of Signals was to plan and install complete signal protection throughout the entire 260 miles between Spencer and Wheeling, at a cost that would not exceed funds available for this purpose. For this reason, automatic block was adopted for the entire territory, in preference to installing a more complete and more expensive signaling system on only a portion of the territory. However, in planning the proposed automatic block, several special features were developed which aid train operation, and also of importance is the fact that, at the ends of sidings, the signals are arranged so that centralized traffic control can be installed at some later date without the necessity for moving signals.

For example, the main line station-departure signals at each end of a siding are opposite the clearance point of the siding. In order to do this at one end, the passing track was thrown over to 20-ft. centers to allow clearance for the high signal to be located between the siding and the main track. The station-entering signal is at the customary location at the right of the track about 114 ft. in approach to the facing-point of the switch.

A practice uncommon in automatic block is that a dwarf type leave-siding signal was installed at the ends of all sidings. Thus the signaling arrangement is modern and complete for automatic block or for future C.T.C.

At each end of every siding, there is a series-type track circuit including the main track between the two high signals, and the turnout as far as the dwarf. Thus, this track circuit is in the proper place for present as well as future adaptations.

The circuit controller, at each passing track switch, controls a switch-repeater relay, contacts of which control the signal circuits. This has advantages compared with ordinary practice of shunting the track circuit. Also, the switch-repeater relay selects the signal controls, as will be discussed later.

At each switch leading to a spur track, there is an insulated joint in one of the main track rails, in approach to the facing point of the switch. The track circuit is connected around this joint through contacts in the switch circuit controller. When the switch is not normal, the track circuit is open and the rails toward the relay are shunted.

### Aspects and Indications

The signals on this project are the searchlight type. The intermediate signals each have a single head to display red, yellow or green. The main-track station-departure head-block signal at each siding switch has a regular searchlight head as the top "arm," and a second "arm" which consists of a single lamp unit displaying red only, thus distinguishing such a signal as an absolute stop signal. Each leave-siding signal is a dwarf, consisting of a searchlight unit. The signals are controlled by the conventional absolute-permissive-block system of circuits to display absolute stop aspects for opposing moves or permissive aspects for following moves.

When a train on a siding is ready to depart via a hand-throw switch, the head brakeman goes to the switch and, if he sees no approaching train, he throws the switch. Circuits, through the switch-repeater relay, place the main-track station-leaving signal 2329 at Stop, as shown at Nelsons in Fig. 2. Then the line controls of that signal are taken over by the leave-siding dwarf 2329 A, so that it displays the same proceed as-

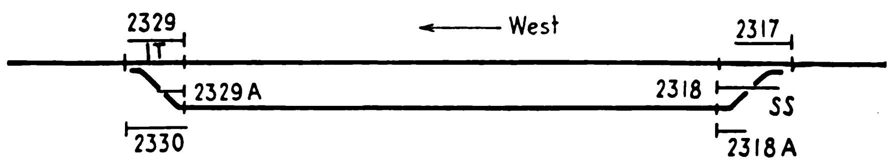
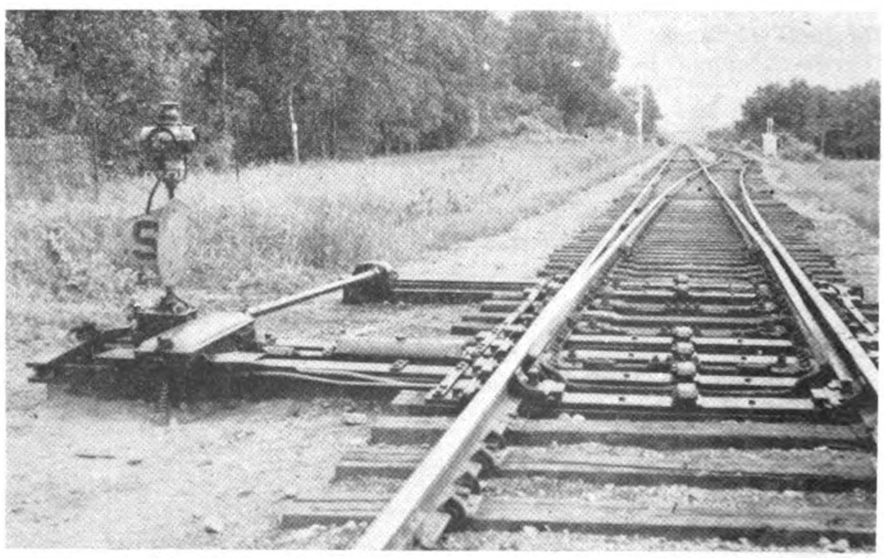
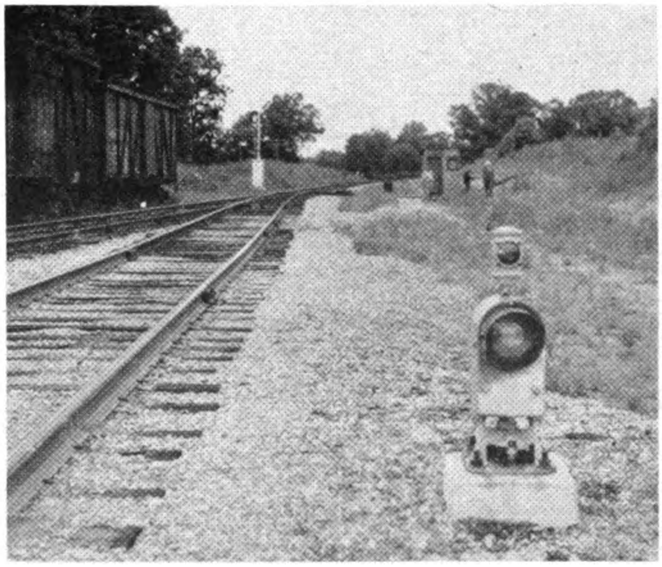



Fig. 2—Siding at Nelsons with spring switch at east end



The spring switch layouts include automatic facing-point locks



**Automatic signaling has leave-siding dwarfs with a white lamp on top which checks overthrow of plunger**

pect as previously displayed by signal 2329. As required by operating rule, three or more minutes waiting time must elapse before the train starts to pull out on the main track. This time is sufficient for any other train, which may be approaching at normal speed on the main track, to arrive within view. After the waiting time interval, the train on the siding accepts the aspect on the leave-siding signal, and pulls out on the main track.

At the siding switches which are equipped with spring-switch mechanisms, such as shown in Fig. 3, the leave-siding dwarf signal 2318A normally displays the green aspect, and the main track station-leaving signal normally displays the same aspect. Thus, a train on the siding approaching the switch has its signal to depart. However, the control of dwarf 2318A is through a front contact of 2317DPR which is a 600-ohm biased neutral relay connected across the line circuit. This relay is normally energized but is released if an eastbound train has passed the third eastward signal west of 2318. As shown in the circuit diagram, the control of 2317DP excludes track relay 1T, the "under lock" repeater relay, ULP, and the reverse switch-repeater stick relay, whereas these are included in the control of signal 2317. Through the control of relay 2317DP, dwarf 2318A would display red if an eastbound train had entered any track circuit controlling signal 2317.

If train orders have been issued to authorize an eastbound train on the siding to depart ahead of a train on the main track, the eastbound train on the main track is stopped short of signal 2318. Then the head brakeman or conductor of the train on the siding operates a push-button on dwarf signal 2318A, which picks up push-button stick relay. This sets signal 2318 at red, and starts a time-element relay which measures three to five minutes. At the end of this interval, leavesiding dwarf 2318A displays a green aspect, providing other conditions are correct. The push-button mentioned above is mounted on the dwarf signal, and is of the weatherproof type including a flexible leather diaphragm cover that prevents rain from entering.

### Protection at Spring Switches

Each spring switch layout includes an oil buffer spring mechanism made by the Pettibone Mulliken Company, and an automatic mechanical facing-point lock mechanism made by the General Railway Signal Company. This mechanism locks the switch in the normal position. When a train, moving from the siding to the main line, starts to trail through the points, the lock is unlocked automatically.

At each spring switch layout, there is a small lamp unit with a 3-in. lunar white lens, mounted on top of the searchlight dwarf leave-siding signal. This lunar white lamp is normally lighted to indicate that the plunger in the automatic mechanical facing-point lock is not in overlock. If the plunger is through the rod too far, this lunar white lamp is not lighted, and the dwarf signal is controlled to display red. Therefore in order to constitute a proceed aspect for a train to trail out from the siding through the switch without stopping, the lunar white light must be displayed, in addition to a yellow or green in the dwarf signal. If the

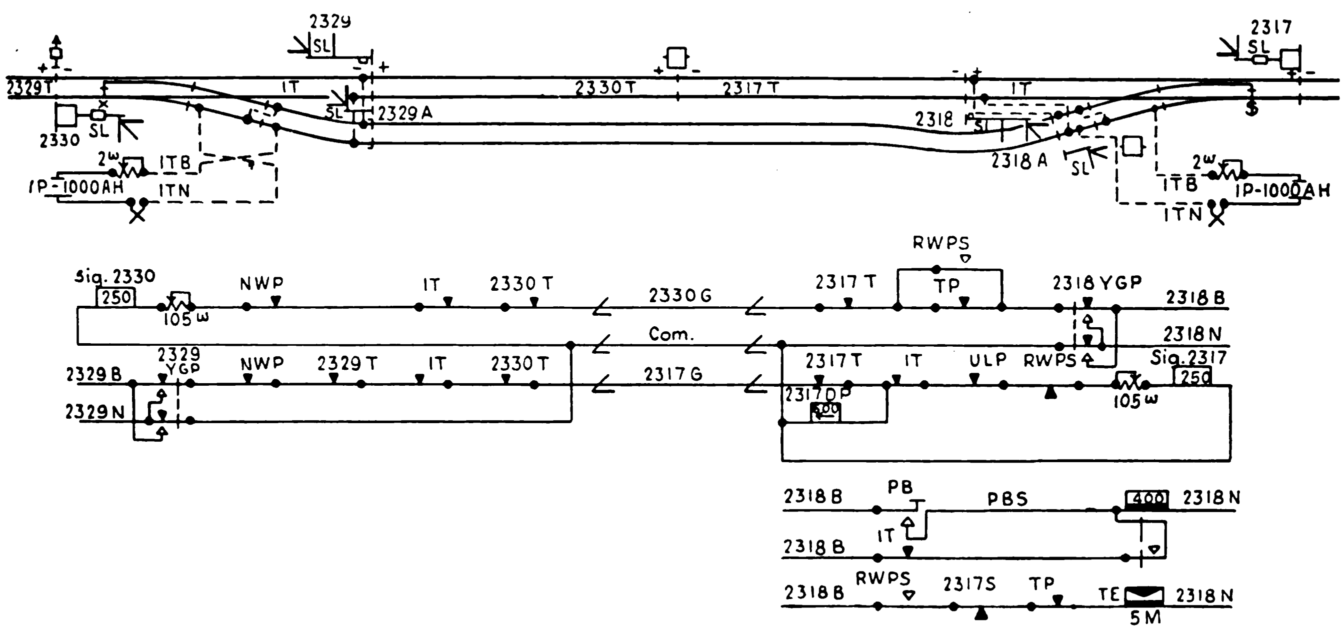



**Fig. 3—Diagram of circuits at siding at Nelsons**

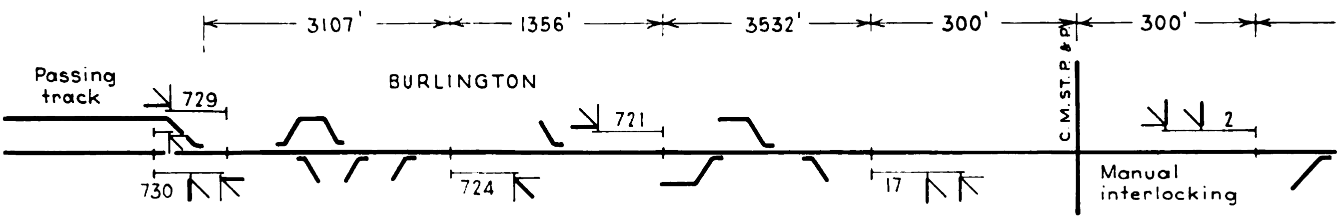



**Fig. 4—Track and signal plan of territory between Burlington, Wis., and**

lunar white lamp is not lighted, a train on the siding must be stopped short of dwarf signal, and the switch must be operated by hand by the head brakeman.

### Automatic Call-On Signals

A unique feature of this Soo Line installation is the use of automatically controlled Call-On signals. A mechanical interlocking is in service at the crossing of the Soo Line and the C.M.St.P.&P. at Burlington, Wis., as shown in Fig. 4. On the eastward Soo Line home signal No. 17, the top "arm" is a searchlight signal which displays red, yellow or green, and the bottom arm is a searchlight signal which normally displays red, but can be controlled to display yellow. The vertical spacing between these two arms is 10 ft. When an eastbound Soo Line train approaches, if the top arm fails to operate, the lower arm will be controlled to display yellow under a red in the top arm thus displaying a "call-on" aspect, indicating proceed at restricted speed. In a corresponding manner, the westward Soo Line home signal No. 2 has a lower arm searchlight signal to display a call-on aspect.

Through the city of Burlington, there are 10 turnouts from the main track to industry spurs and house tracks. All these turnouts are within the 1.6 miles from the interlocking through Burlington to the east end of the siding as shown in Fig. 4. Most every day the local freight train works for an hour or more serving these various house tracks and spurs, a part of the train being left on the main track. This section of track is within the station-to-station territory between the passing siding at Burlington and the passing siding at Silver Lake. In order to permit a westbound train to continue through Silver Lake toward Burlington, while the local train is occupying the main track at Burlington, the two signals at the intermediate double location 697-698 were made two-arm signals as shown on Fig. 4. On westbound signal 697, the lower arm is a two-position searchlight signal, which can display a yellow (under red in the top arm) to give a call-on aspect to permit a westbound train to pass at restricted speed. Thus, if the section between the interlocking and the east end of the passing track at Burlington is occupied by the local freight, a westbound train can continue westward at normal speed until approaching signal 697) then—after reducing to restricted speed—the train can pass signal 697 and continue westward, to stop short of the local freight if it has not cleared the main track in the meantime.

The call-on aspect on eastward Soo Line home signal 17, permits the switch engine to make a move over the interchange track while a westbound train is on the way from Silver Lake.

### Call-On at Leithton

Formerly there was a passing siding at Mundelein, the east end of which was only about one-half mile west of the east end of the siding at Leithton. The old siding, is not to be used for passing trains, and, therefore, no head-block signals were installed. See Fig. 5. Thus, the siding-to-siding block is between westward signal 389 at the west end of Leithton and eastward signal station-leaving signal 508 at the east end of the siding at Lake Villa.

As a special feature, westward intermediate automatic signal 405 at Mundelien has a second arm, (which is a fixed red) thus designating it as an absolute signal. Westward station-leaving signal 389 at the west end of Leithton, has a second arm which is searchlight signal head. This second arm normally displays red. However, if an eastbound train has passed the east end of Lake Villa, signal 389 at Leithton will display the call-on aspect, red-over-yellow, to authorize a westbound train to proceed to signal 405 at Mundelein. Another phase of this layout is that a train occupying the main track at Mundelein does not prevent an eastbound train from leaving Lake Villa and proceeding to Mundelein in the usual manner.

### Spacing of Intermediates

As a general rule the intermediate signal locations are double. Two such double locations of intermediate signals were installed where the distance between signaled sidings is about 6 miles or more, as for example 5.9 miles between Sheridan and Waupaca, as shown in Fig. 6. The first block west of Waupaca is 8,875 ft. and the first block east of Sheridan is 8,735 ft., thus leaving a long center block 14,160 ft. in length. This spacing provides a shorter block adjacent to each siding so that an eastbound train, for example, that is to take siding at Waupaca for a following train, can have maximum time to get in the clear, without stopping the following train. If a westbound train, for example, is on the siding at Waupaca, for a westbound passenger train, the short block from signal 2211 to 2229 permits the passenger train to clear this block sooner, thus allowing the freight to depart from the siding sooner. All blocks are adequate in length for train stopping distance.

The underground wires, from

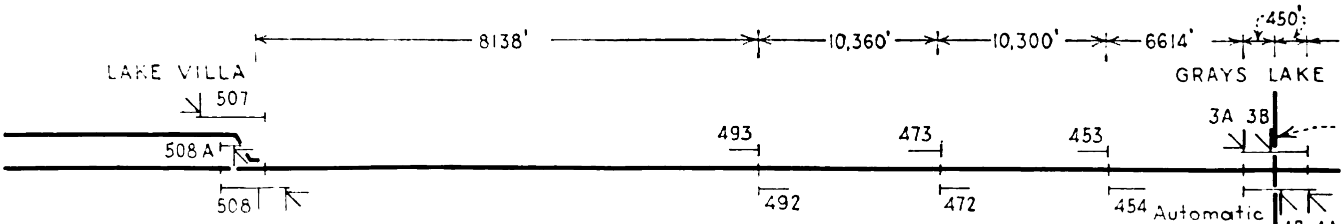
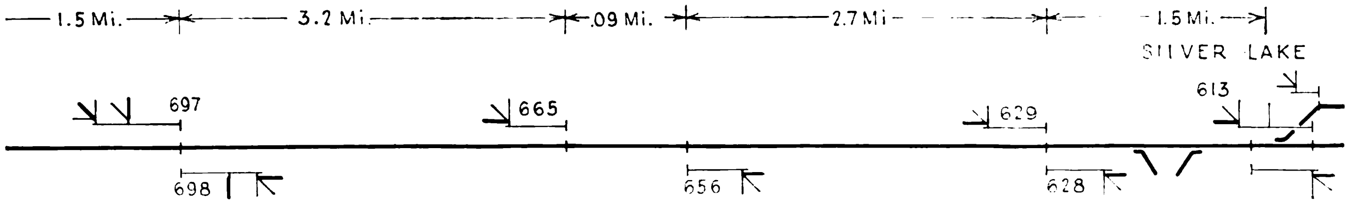



**Fig. 5—Track and signal plan of territory between Lake Villa**

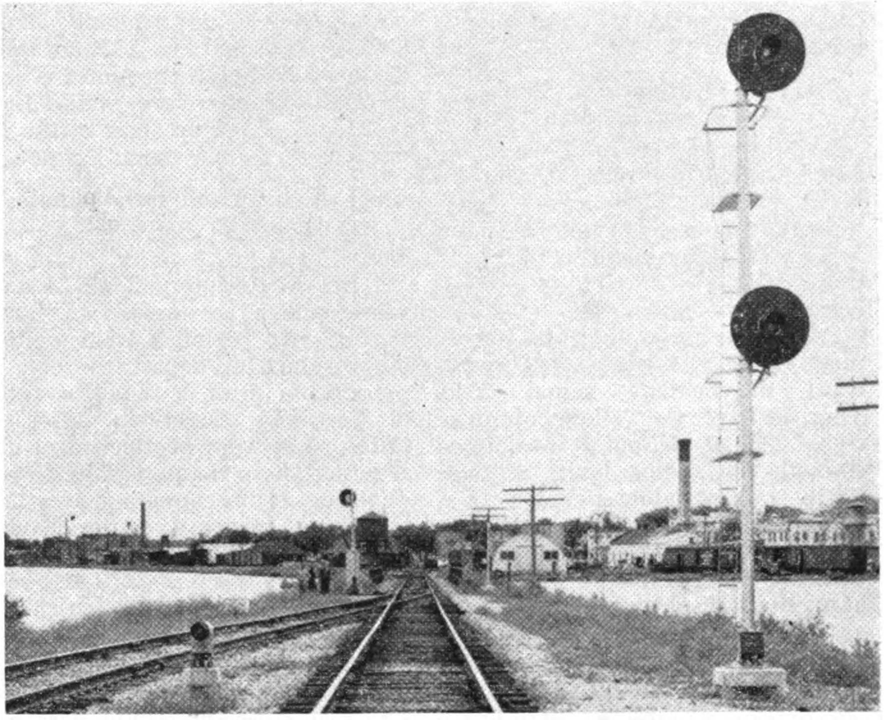


Silver Lake, illustrating the use of call-on signals

cases to bootleg outlets at rails, is No. 8 solid copper with 3/64-in. Neoprene covering. These wires are buried about 30 in., and are laid at least 6 in. apart.

The undergound cable which runs under the track, from a case on the pole line side to the signal on the other side, is nine-conductor, including two No. 8 for lamp circuits and seven No. 14 for control and indication circuits. The aerial cables from the top of the signal cases to the line poles are the self-supporting type. The wires are No. 12 solid copper, with 5/64-in. insulation and 1/64-in. Neoprene covering. These cables, either five, seven or nine conductor, are made up in the factory using 8-gage bare Copperweld as a messenger and a spiral winding of Copperweld strap 5/16-in. wide. The connections from the wires in the line cable to the line wires are made with Nicopress sleeves.

The line wires are No. 9 copper for 110-volt a.c. power distribution and the three line wires for the signal line circuits are No. 9 Copper-


Signals at east end of siding at Burlington

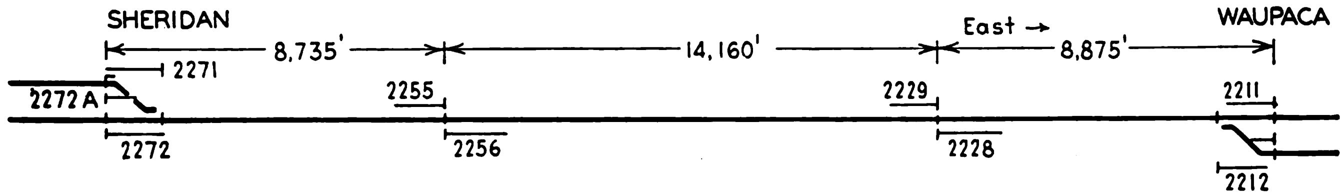


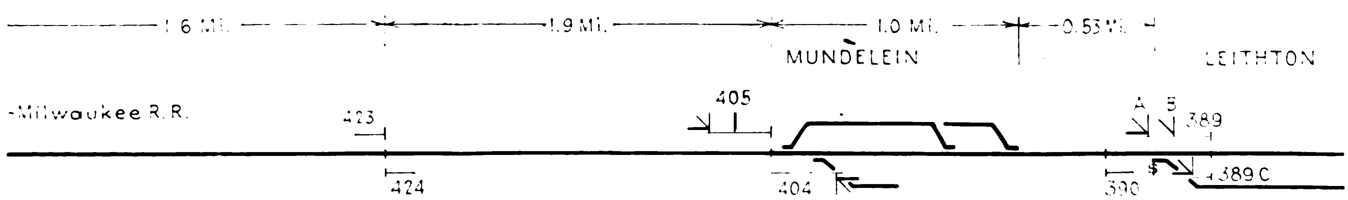
Fig. 6—Spacing of intermediate signals between Sheridan and Waupaca

weld. On the territory between Spencer and Neenah, the line wires were furnished by the Anaconda Wire & Cable Company, have Duraline weatherproof covering. On the section between Neenah and Wheeling the line wires furnished by Anaconda have polyethelene plastic weatherproof covering.

The wiring in the cases is flexible, and is run in loops on the face of the panel boards. The arresters are the Clearview type made by Railroad Accessories Corporation. The ground rods are 5/8-in. by 8 ft. Copperweld, and a network of ground connections includes the signal masts, ladders, cases, and foundation bolts.

The 110-volt a.c. power, coming into each case, is fed through a Square-D automatic circuit-breaker instead of using fuses.

Each line battery consists of seven or 8 Edison B4H storage cells, rated at 75 a.h. This battery normally feeds the line circuit and the 250-ohm operating coil of the searchlight signal. The signal lamp is normally fed continuously on a.c. power. If the a.c. fails, the lamp is fed, on approach lighting control, from the storage battery. As a means of isolat-



and Leighton, showing controls of call-on signals

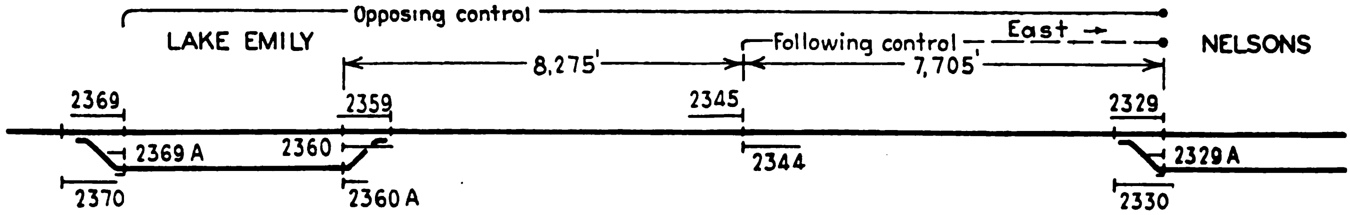



**Fig. 7—Yellow overlaps for single intermediates between Lake Emily and Nelsons**

ing the lamp circuits at a double location, a 4-contact power-off relay is used.

### Yellow Overlaps for Single Set of Intermediates

The distance between Lake Emily and Nelsons is only 15,980 ft. which is about three miles. Therefore, only one set of intermediates was installed as shown in Fig. 7. In this layout, for example, the westward station-leaving signal 2329 at Nelsons, for opposing train movements, repeats the aspects of westward intermediate signal 2345. Thus, in effect the yellow control of signal 2329 at Nelsons is overlapped through the station limits at Lake Emily and including signal 2369 at block at the west end of that siding.

However, for following westbound trains, westward signal 2329 at Nelsons displays yellow as soon as the rear of a westbound train passes the intermediate signal 2345.

An interesting feature is that the result discussed above is accomplished without extra line wire. At signal 2345, the line control for signal 2329 is polarized through contacts of a green repeater rather than as ordinarily through a yellow-green repeater. Thus for an opposing move, i.e., with 2345 stick relay down, when signal 2345 goes from green to yellow its 2345 GP is released which poles the line circuit to set signal 2329 at yellow also.

In contrast, when a westbound train passes signal 2345, the stick relay 2345 is picked up, which with 2345 YGP and 2345 GP both released, causes poled feed to the line to display yellow on signal 2329. This circuit does not require extra line wire.

In this layout, the controls for the eastward signals are correspondingly similar to those for westward signals as explained above. Therefore, opposing trains, approaching signal 2329 at Nelsons and 2360 at Lake Emily, would both encounter yellow aspects, and, therefore, would both be prepared to stop short of the intermediate double signal location.

### Set of Staggered Intermediates

The distance between Nelsons and Sheridan is 4 miles, and there are two single intermediate signals. These signals are located as shown in Fig. 8 to permit a train waiting on a siding to depart as soon as practicable after a superior train, of the same direction, passes. If train orders were overlooked or disregarded there is a possibility of two opposing trains simultaneously approaching eastward station-leaving signal 2318 at Nelsons and westward station-leaving signal 2279 at Sheridan. In such an instance, both these signals would display yellow so that both trains could be stopped short of their respective intermediate signals.

At signal 2291, the line circuit for signal 2279 is poled through contacts in a special relay 2291DP which is controlled by a separate line circuit. This circuit extends through a front contact of track relay 2371 T, whereas the control of line circuit for signal 2291 does not. See circuit in Fig. 3.

The result is that when an eastbound train occupies track circuit 2317T at Nelsons, both signal 2291 and signal 2279 display yellow. Relay 2291DP is a retained-neutral relay so that the relay stays energized regardless of the polarity of the current in the line. At signal 2317, the line control for signal 2291 is poled through contacts of a green repeater of signal 2317.

The siding at Nelsons is used frequently for making meets. An advantage of a separate line circuit 2291DP is that it reduces the time that signal 2279 is yellow in case of a meet at the east end of Nelsons. That is, the westward train leaving the west end of Sheridan would receive one green and one yellow signal indication, instead of two yellows enroute to Nelsons.

### Batteries and Housings

The primary batteries to feed track circuits are in concrete battery boxes. When making each box, a 1½-in. galvanized iron pipe is set vertically in one of the inside corners, and is cast in place in the concrete. This pipe serves as a wire entrance, the cable being brought up through a hole in the bottom of the box and up through the pipe. Thus there is no exposed section of cable above ground level. Also the cable can be sealed in the riser pipe, thus making it water tight.

### Track Circuits

The track circuits are the conventional d.c. neutral type, using Type K four-ohm relays. Each ordinary track circuit is fed by two cells of 1,000-a.h. Edison primary battery. Only one such cell is used to feed short track circuit, such as on turnouts.

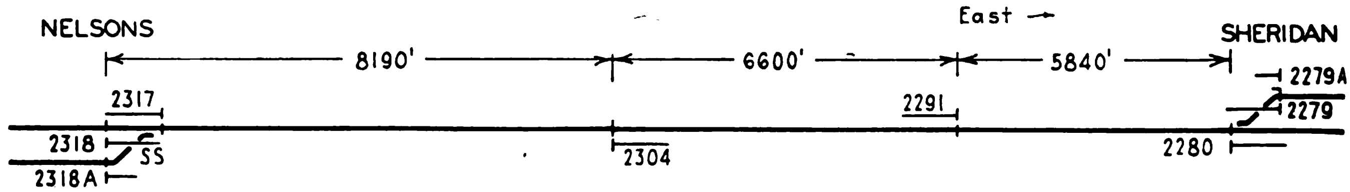



**Fig. 8—Staggered intermediate signals between Nelsons and Sheridan**

### Constructed by Railroad

This signaling project was planned and constructed by railroad forces under the jurisdiction of B. F. McGowan, superintendent of signals, with C. R. Holmberg, assistant superintendent of signals, in charge of construction in the field. The major items of signaling equipment were furnished by the General Railway Signal Company, the instrument cases, battery boxes and concrete foundations being furnished by the Griswold Signal Company.