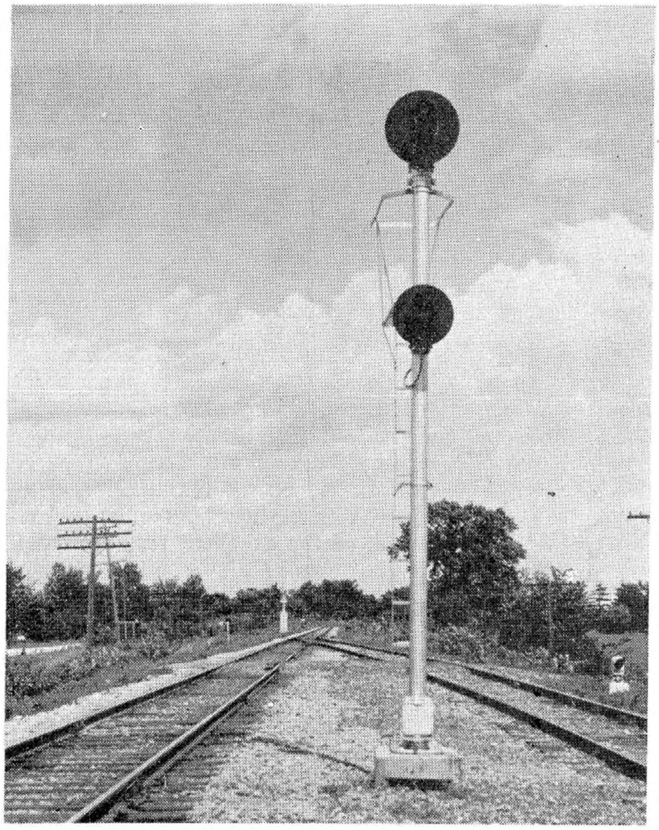
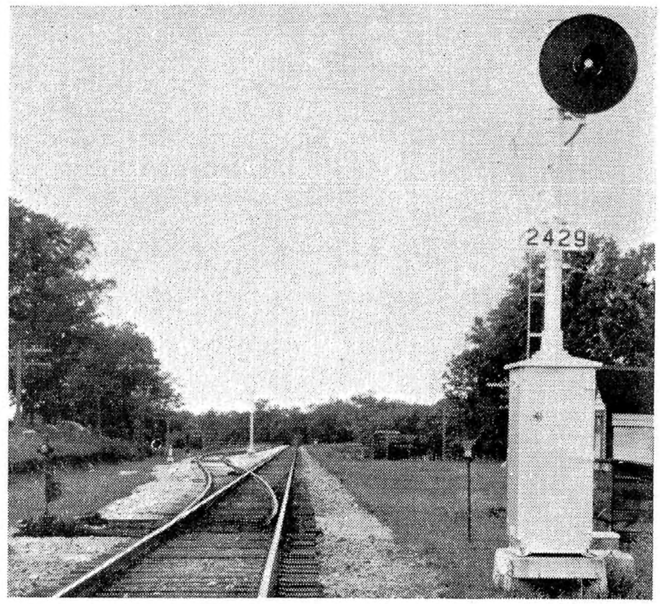
192 Miles of



Signal between main track and siding



Signal at spring switch

Modern arrangement of signals at sidings; special protection at spring switches; and continuous lighting for motor car protection—Construction was well organized

An installation of automatic block signaling is now nearing completion on 192 mi. of single-track main line between Spencer, Wis., and Waukesha, on the Wisconsin Central, operated by the Minneapolis, St. Paul & Sault Ste. Marie. This is a portion of the Soo Line route between Chicago and Minneapolis, through to points in Dakota, Montana, Manitoba and Saskatchewan, where connections are made at Winnipeg, Man., and Portal, Sask., with the Canadian Pacific to Vancouver, B.C., and other Pacific ports. Spencer is a junction with a line to Ashland, Wis., on Lake Superior, and Owen, 19 mi. west of Spencer, is a junction with a line to Duluth, Minn., an important port on Lake Superior. The 192 mi. between Spencer and Waukesha was selected to be equipped with signaling first because more trains are handled than west of Owen. The daily traffic includes 4 passenger trains and about 14 to 16 freight trains. Extra trains are operated as required.

Between Spencer and Waukesha the grades are level to slightly rolling, and, as a rule, do not exceed about 0.5 per cent except for about 1 mi. of 1.0 per cent ascending eastward just west of Medina Junction, and about 2,000 ft. of 1.02 per cent ascending westward west of Neenah. Curves are relatively few, and most of them are 1 per cent or less except for one at Neenah which is 3 deg. and fourteen curves that range from 1 deg. 30 min. up to 2 deg. 30 min. Thus, the grades and curves do not materially affect maximum train speeds.

Sidings Lengthened

Within the last few years, a considerable number of the sidings have been lengthened to hold 100 to 125 cars, and new No. 15 turnouts were installed at these sidings. In addition to automatic block, the signaling on this territory includes remotely-controlled power-operated switches and signals at four ends of sidings or junctions, and spring switches at 11 ends of sidings.

Of special interest is the fact that the new signals at ends of sidings are all located as required in centralized traffic control, so that a change-over at a later date to C.T.C. would require a minimum of expense with respect to the signals. For example, the main line station-departure signals at each siding are opposite the clearance points on the siding. This means, at one end, that the siding track was thrown over to 20-ft. centers to provide clearance for the high signal to be located between the siding and the main track. Also on each end of each siding, there is a dwarf type leave-siding signal. At such locations, there is a separate series-type track circuit including the turnout as far as the dwarf and the main track between the station-entering and the station-leaving signal. The circuit controller on each passing track switch controls a normal switch-repeater relay which in turn controls the signal line circuits. This arrangement has certain advantages as compared with conventional practice of shunting the track circuit and, furthermore, the use of the switch-repeater relay selects the control of signals.

At each spur track, there is an insulated rail joint in one of the main track rails in approach to the facing point of the switch. The track circuit is taken around this insulated 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.

Lock Check

Each spring switch includes an automatic mechanical facing-point lock which locks the switch point in the normal position. When a train

Automatic Block On Soo Line

starts to move from the siding to the main track, 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 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. On the other hand, this lunar white lamp is extinguished if the plunger is through the rod too far and the dwarf signal displays red. Therefore, the lunar white lamp must be displayed in addition to the green or yellow in the searchlight dwarf signal in order to constitute a proceed aspect to trail out through a spring switch without stopping. If the lunar-white lamp is not lighted, a train on the siding must be stopped short of the switch, and the switch must be operated by hand by the head brakeman.

Continuous Lighting

On this installation, the lamps in all signals are lighted at all times, except when the a.c. power supply fails, in which case approach lighting goes into effect on all signals except the leave-siding dwarfs which burn because there are no track circuits on the sidings to use in approach lighting control. An advantage of having the signal lamps lighted at all times, when a.c. is available, is that the aspects displayed are a help to men on motor cars and automobile rail cars to indicate the approach of trains. The lamps in train-order signals are flashed about 30 times per minute, thus making the aspects of these signals distinctly different from that of automatic block or interlocking signals. All signal lamps on this new installation are 11.3-volt, 13.3 watts, thus facilitating replacements and supply of lamps.

Sheet-Metal Cases

The signal relay and battery cases are the welded sheet-metal type. Each case has a door on the track side and a door on the field side. The relays are on the track side of a partition and the power-off relay, transformer, rectifier and storage batteries are on the field side. Each relay case door is held in the closed position by two rotating latches which are operated by a handle on the outside of the door. This handle is locked by a counter sunk machine screw with a ½-in. hexagonal head, the same size as the nuts on a Signal Section, A.A.R. relay terminal post. Therefore, these door handles can be locked or unlocked by using a standard socket wrench. The inside walls, ceiling and floor of these cases are insulated with a compound about ¼ in. thick which is applied by spraying. This compound is a non-metallic substance made by the Minnesota Mining & Manufacturing Co. These cases, with signal masts on top, are mounted on precast concrete foundations, the cases designed to allow about 1 in. space for free circulation of

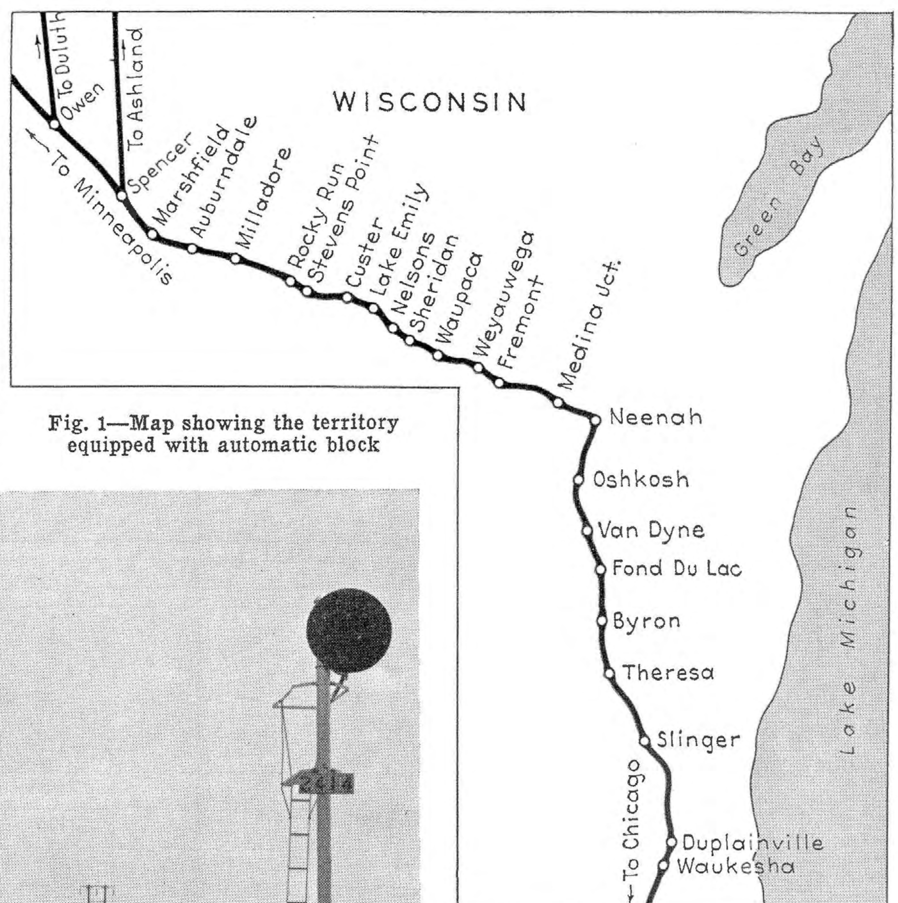
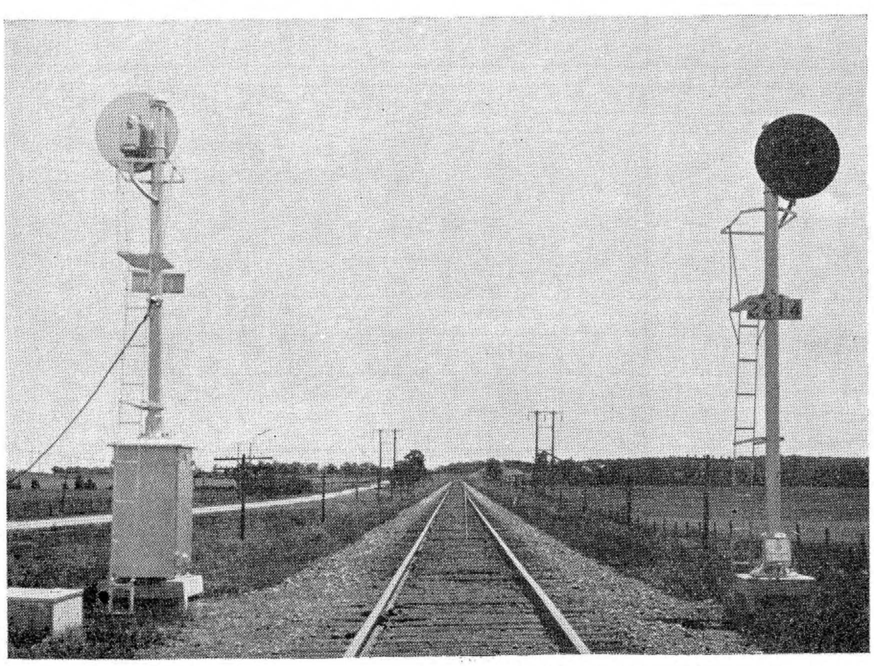


Fig. 1—Map showing the territory equipped with automatic block



A double intermediate signal location between Stockton and Lake Emily

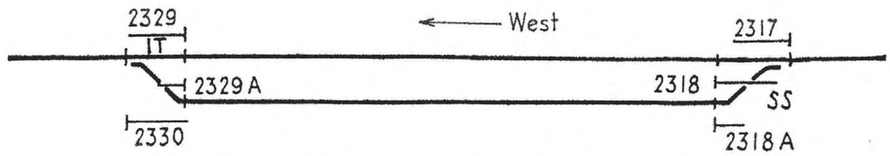


Fig. 2—Track and signal plan of siding at Nelsons with spring switch at the east end

air end to end between the top of the foundation and the bottom of the case. This minimizes dampness in the case.

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 2329A, so that it displays the same proceed aspect 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 D2317 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 main track, the train eastbound 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, leave-siding 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.

Spacing of Intermediates

Two double locations of intermediate signals were installed where the distance between sidings is about 6 mi. or more, as for example, 5.9 mi. between the east switch at Sheridan and the west switch at Waupaca, as shown in Fig. 6. The first block east of Sheridan is 8,735 ft. long and the first one west of Waupaca is 8875 ft., leaving the center block 14,160 ft. long. The purpose of so spacing the intermediates is to provide a shorter block adjacent to each siding, so an eastward freight 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. Also, if a westbound freight, for example, is

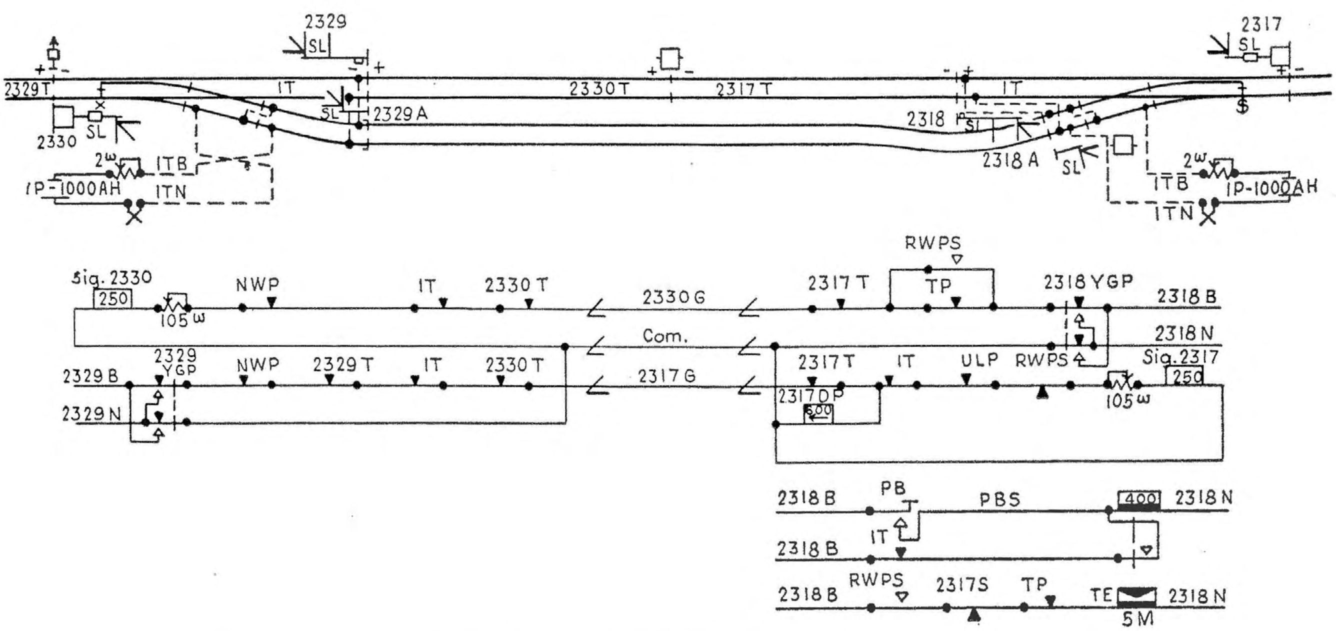


Fig. 3—Diagram of circuits at siding at Nelsons

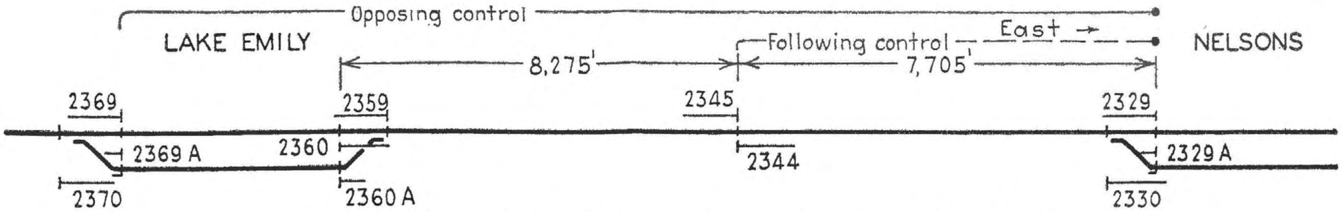


Fig. 4—Yellow overlaps for single intermediates between Lake Emily and Sheridan

on the siding at Waupaca for a westbound passenger, the short block from signal 2211 to 2229 permits the passenger train to clear this block sooner, and thus allow the freight to depart from the siding that much sooner. All blocks are plenty long enough to provide adequate braking distance.

Yellow Overlaps for Single Set of Intermediates

Between Lake Emily and Nelsons, where the distance is 15,980 ft., which is about 3 mi., there is only one double location of intermediate signals, as shown in Fig. 4. In this arrangement, for example, westward station-leaving signal 2329 at Nelsons, for opposing train movements, repeats the aspects of westward intermediate signal 2345. This means, in effect, that the yellow control of signal 2329 at Nelsons is overlapped through station limits at Lake Emily and including signal 2369 at block at the west end of that siding. For following westbound trains, however, westward signal 2329 at Nelsons displays yellow as soon as the rear of a westbound train passes the intermediate signal 2345.

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

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

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

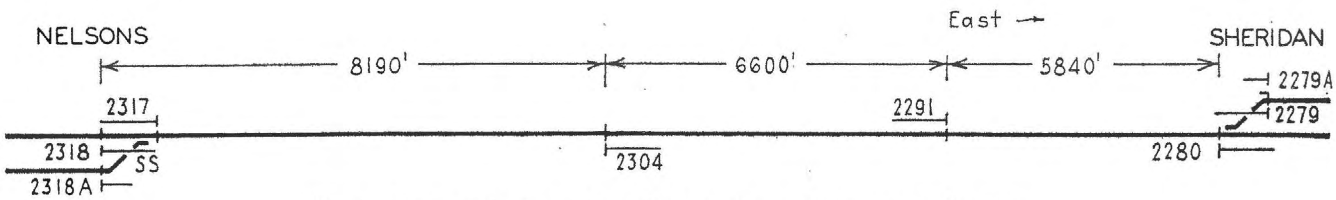


Fig. 5—Staggered intermediate signals between Nelsons and Sheridan

Between Nelsons and Sheridan, the distance is 4 mi. and there are two single intermediates, which are located as shown in Fig. 5, 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. Under such a circumstance, both of 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. This 2191DP relay is controlled by a separate line circuit which, at Nelsons, extends through a front contact of track relay 2317T, whereas the control of the line circuit for signal 2291 does not. See circuits 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 neutral relay across which is a rectifier connected in a line circuit so that the relay gets energy in the same direction 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 when making train meets. The advantage of the 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 west end of Sheridan would receive one green and one yellow signal indication instead of two yellow signals enroute to Nelsons..

Batteries and Housings

The primary batteries to feed the 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 in through the hole in the bottom of the box and up through

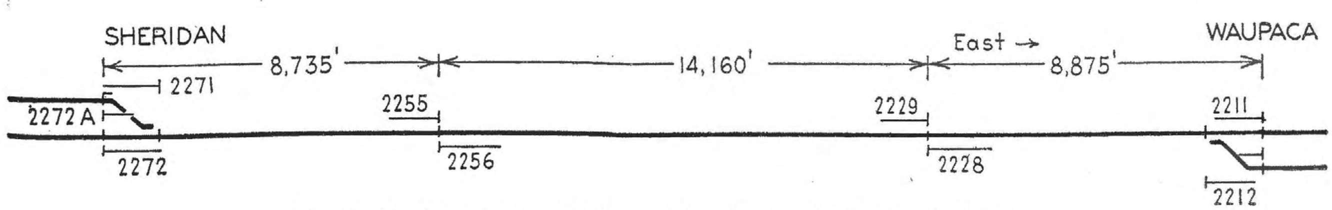
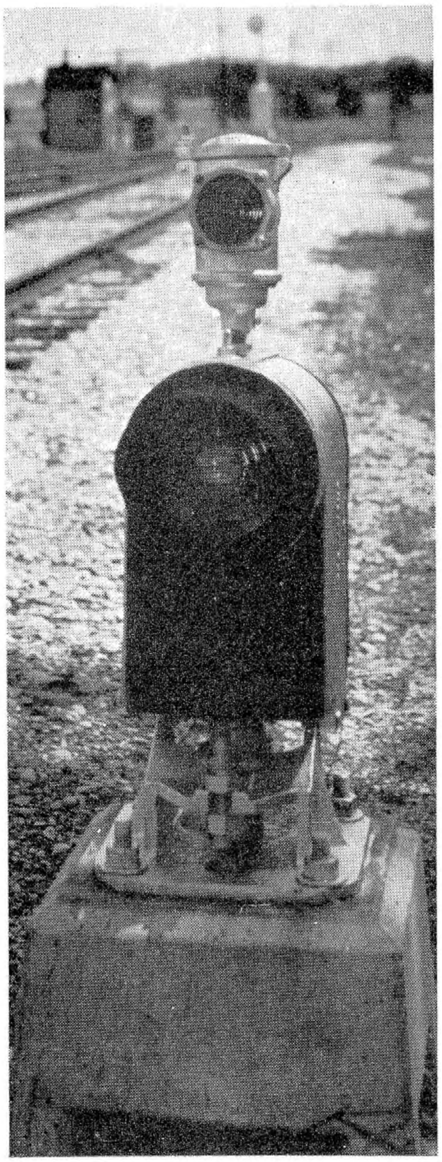


Fig. 6—Spacing of intermediate signals between Sheridan and Waupaca

the pipe. The advantage is that there are no exposed sections of cable, or cable entrance, above ground level. Also the cable can be sealed in the riser pipe, thus making the entrance water tight.

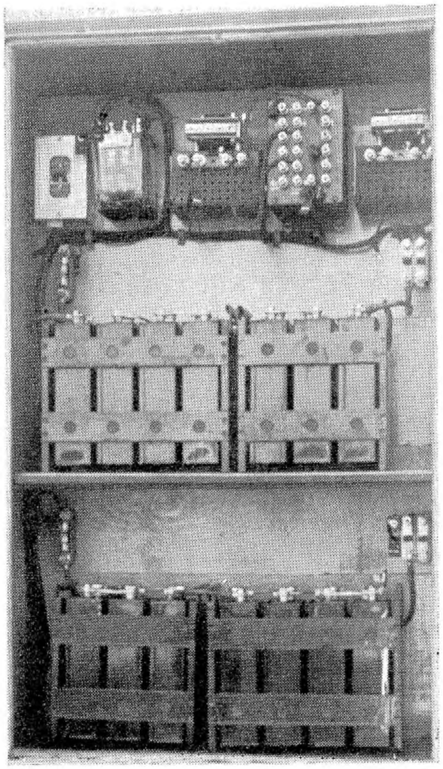
As shown in one of the accompanying pictures, the wiring in the cases is flexible, and is run in loops on the face of the panel boards. The arresters are the Clearview type made by the Railroad Accessories Corporation. The ground rods are 5/8 in. by 8 ft. Copperweld, and a network of ground connections 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 cells of Edison B4H storage cells rated at 75 a.h. This battery normally feeds a line circuit and the 250-ohm operating coil of the searchlight signal. The signal lamp is normally fed continuously on a.c. power, but if that fails, the lamp is fed on approach lighting control from this storage battery. In order to isolate the lamp circuits at a double location, a 4-contact power-off relay is used.



Small lamp unit on top of leave-siding dwarf indicates that the plunger in the facing-point lock is not in overthrow

The track circuits are the conventional d.c. neutral type, using Style K 4-ohm relays. Each ordinary track circuit is fed by two cells of 1,000-a.h. Edison primary battery connected in multiple. Only one such cell is used to feed the short track circuit, including turnouts at ends of sidings.

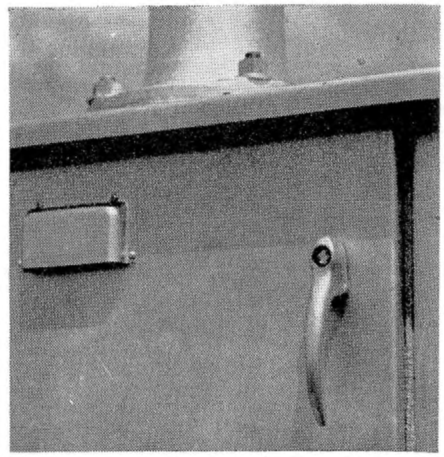


Storage batteries and rectifiers in the field side of steel case

Stranded bonds, using 3/8-in. pins in the web of the rail, were used on the territory between Spencer and Neenah, and Cadweld bonds, applied to the side of the head of the rail, were applied on the more recent construction between Neenah and Waukesha. The number plates on these signals are a new type made of 1/16-in. sheet aluminum with clear anodizing. The black on the number is a fadeless black anodizing applied during manufacture. Thus, the numbers, frame and bolts in these number plates will never need be painted, and will not rust or otherwise deteriorate.

Wires and Cables

The underground wire from cases to bootleg outlets at rails is No. 8 solid soft-drawn copper with 2/64-in. Neoprene covering. These wires are buried at least 30 in. and are laid at least 6 in. apart. The bootleg risers are made of 1¾ in. galvanized pipe with a 1¾-in. by 1½-in. street elbow at the top. A Nicropress sleeve is used to connect the No. 8 wire to the 7-strand No. 12 Copperweld conductor which extends to a 3/8-in. plug in the web of the rail. This joint is pushed down in the vertical pipe, and the stranded conductor comes out through the center of a wood plug that fits in the 1½-in. opening in the street elbow.



These door handles are unlocked by means of a socket wrench

The underground cable which runs under the track, from a case on the pole line side to a signal on the other side, is nine-conductor, including two No. 8 for lamp circuits and seven No. 14 for controls 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 3/64-in. insulation and 1/64-in. Neoprene outer cover. These cables, either 5, 7 or 9 conductor are made up in cable at the factory using 8 gage bare Copperweld as a messenger, and a spiral winding of Copperweld strap 3/16 in. wide. The connections from the wires in the line cable to the line wires are made with Nicropress sleeves.

The line wires are No. 9 copper for the 110-volt a.c. power distribution and the three line wires for the signal line circuits are No. 9 Copperweld. On the territory between Spencer and Neenah, the line wires, furnishes by the Anaconda Wire & Cable Company, have Duraline weatherproof covering. On the section between Neenah and Waukesha, the line wires, furnished by Anaconda, have polyethelene plastic weatherproof covering.

Constructed by Railroad

This signaling was planned and installed by railroad forces. On the 100 mi. between Spencer and Neenah, the

(*Continued on page 673*)

tions at our maximum reach of operations, which is 5 mi. Tests have shown, however, that we can be picked up 22 mi. from our station.

The land-station equipment is located in the approximate center of our terminal area in the radio maintenance shop. The equipment used consists of a Communications Company Model 172-T 15 watt transmitter, two Model 189-R receivers to provide simultaneous dual-frequency standby, remote control amplifier, speaker, control panel and handset. A Model 244-P broad-band, high-gain antenna has recently been installed. The remote control and dispatch point utilize Model 206 combination intercom and radio controls. This equipment is the same at remote control locations and dispatch locations. The train director's office is classified by the F.C.C. as "remote control point" and the yardmaster's office as "dispatch point."

Each mobile equipment consists of a Model 172/173 transmitter-receiver unit, with a 32-volt d.c. power supply which operates from a 32-volt 1,000-watt steam driven headlight generator on the steam engines. The same equipment with a 64-volt power supply is used on the Diesels. An additional control unit with speaker and handset is mounted on the rear of the tender for use by the conductor and switchmen. A simple quarter-wave, whip-type, ground-plane antenna is used on all of our mobile equipment and has been found to be equal to or better than some of the more elaborate types tried.

Many Advantages

The features of this particular installation are instant communication between train director, switch engine crews and yardmasters, and other towers. This steps up the speed in switching and eliminates the time wasted in walking to the nearest telephone, and gives better over-all efficiency and service to the public. However, the Jacksonville Terminal considers the safety feature one of the most important. In our operations serious oversights such as running signals, or other possible accidents, can be largely controlled by the train directors who can instantly direct the engineer to stop, or he can otherwise control his movements in an emergency by radio. In case of personal injury, or other emergency, the crew can immediately talk to the train directors and yardmasters and protect things such as split switches, broken rails and obstructions. In fog, haze or other bad operating conditions, the tower can keep the engineer completely posted so that practically no time is lost from normal speed in doing the work. Since the information is broadcast to all engines who are operating on that particular frequency, all of the crews are posted as to what is going on, especially if it is something out of the usual.

This installation paid for itself during the first 12 months of operation on the Jacksonville Terminal, amortized the complete investment in payroll savings and enabled the terminal to operate with one less switch engine per day because of savings in time, and the other features mentioned above. The total cost of the project was $16,-000, the major items of radio communication equipment having been furnished by the Communications Company.

Automatic Block on Soo Line

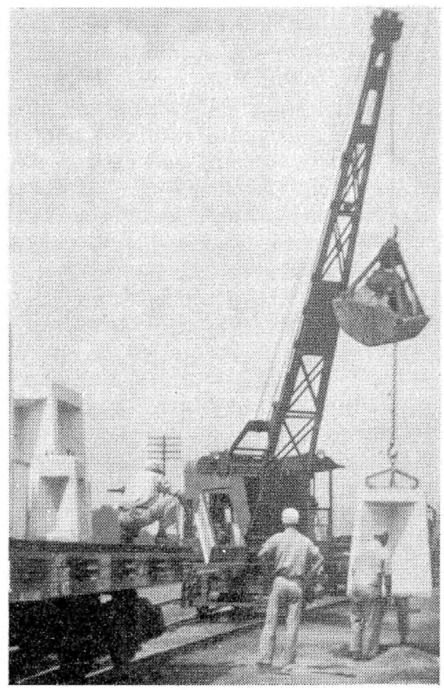
(*Continued from page* 670)

construction headquarters were at Stevens Point, and on the 92 mi. between Neenah and Waukesha, the construction headquarters were at Shops near Fondulac. The signal relay and battery cases are the sheet-metal type. These cases were wired complete with relays, rectifiers, transformers and arresters in place. This work was done by a Soo Line signal crew working in a shop at Minneapolis. In the meantime, other crews were doing the line work, and the bonding, and were assembling other materials. For example, at Fondulac a crew assembled the signals, ladders and masts as shown in one of the accompanying pictures. The cases were shipped from the shop at Minneapolis in gondola cars. When such a shipment arrived at field construction headquarters, a work train was made up to include cars of pre-cast concrete foundations and battery boxes, also a Burro crane mounted on a railed flat car.

When this train arrived at a proposed signal location, the clam-shell on the Burro crane was used to excavate for the signal foundations. Then the crane was used to set the concrete signal foundations in place and backfill them. Under favorable conditions, a foundation at a signal location could be completed in from 7 to 12 min.

A second work train distributed and set instrument cases, signals, cable post, relay boxes. Also this train distributed switch boxes, parkway outlets and insulated rail joints. Signals and instrument cases were loaded in proper order on flat cars and gondolas. The Burro crane on a railed flat car was placed between a car of signals and a car of cases. Cars were so loaded that both signal and case cars were emptied simultaneously at a time and place where one switching operation of the work train could set out the empties and place the next cars in proper position in the work train. The same plan was followed on the foundation and battery box work train. Signal masts were assembled completed with ladders, mechanism housing, conduit, etc., in the material yard, and then loaded onto the work train. In one day all the cases, signals, etc., were distributed and put in place between Spencer and Stevens Point—8½ hr.

After operating the work trains, the signal crews installed the underground cables and the aerial cables, and connected these wires to terminals



Crane used to set foundations

or arresters in the cases, and signals. The switch circuit controllers are the Model 7, and were installed with ¾ in. by 5-in. galvanized lag screws. All this work was coordinated with the bonding and line work so the signaling as a whole would be completed about the same time on extended section. Then the circuits were tested and the signal was placed in service.

This signaling project was planned and installed by company 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.