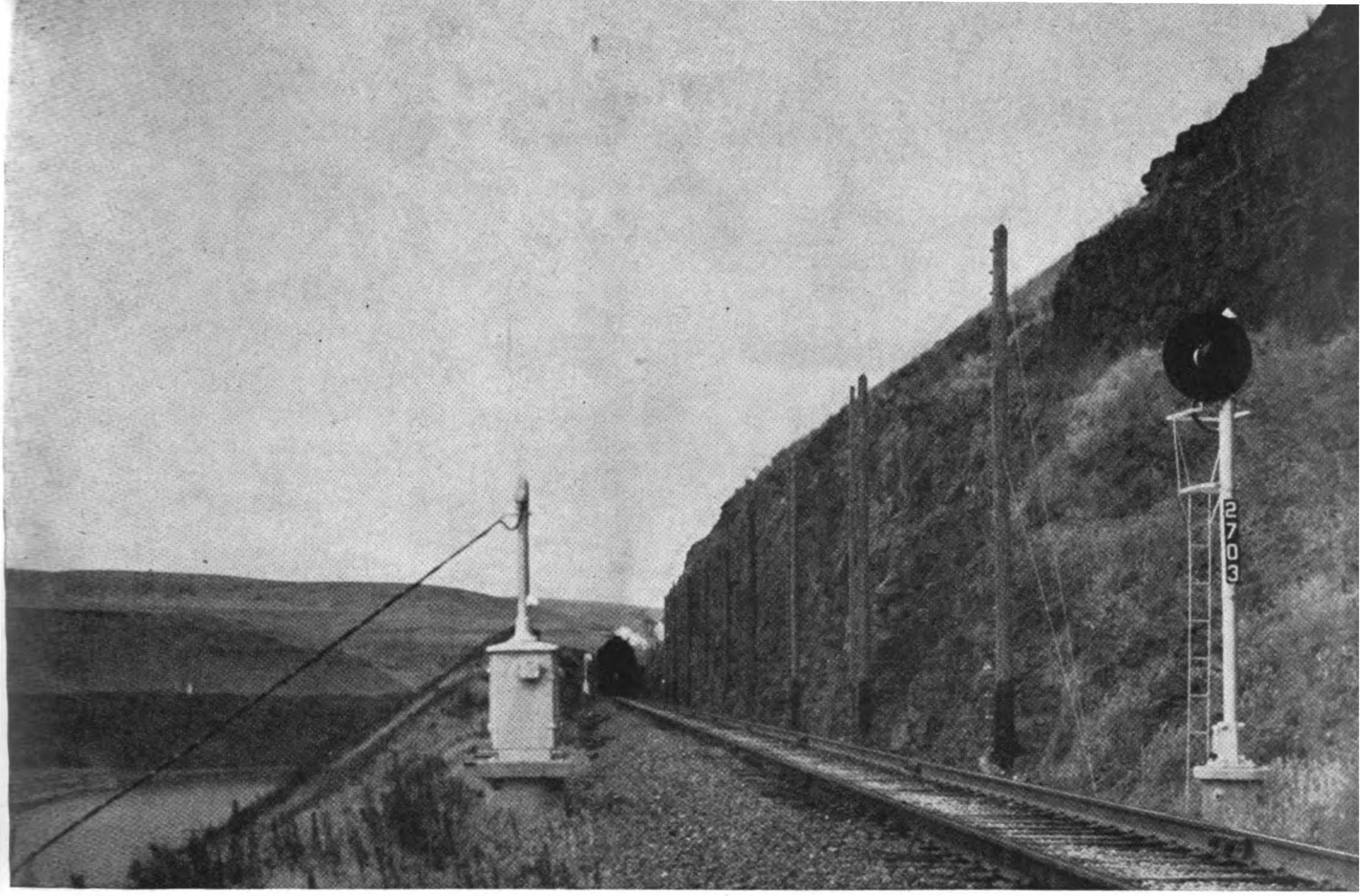


Intermediate signal location and slide-fence protection along the Snake river between Farrington, Wash., and Kahlotus

Signals and Slide Fences on the Spokane, Portland & Seattle

Project includes installation of automatic block on 147 mi., station-protection signals at 22 passing tracks and 44,810 ft. of slide-detector fences

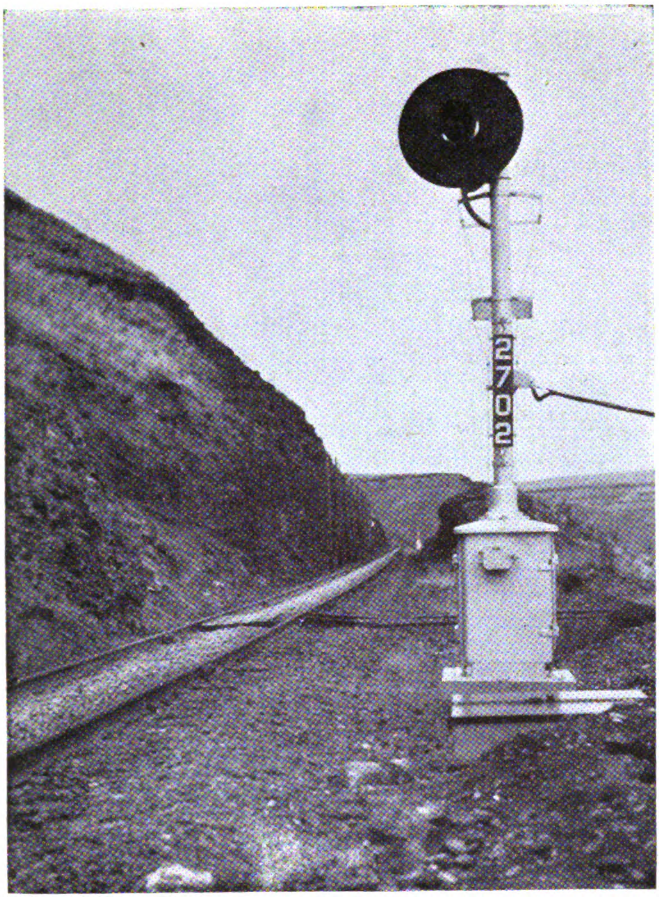
THE Spokane, Portland & Seattle has completed an installation of automatic block, station-protection signals and slide-detector fences on 377 mi. through the Cascade mountains from Portland, Ore., to Spokane, Wash., shown in Fig. 1. Included in the project are 147.4 mi. of single-track A.P.B. signaling in scattered sections; station-protection signals at 22 passing tracks; and 44,810 ft. of slide-detector fences.

From Portland, a double-track main line crosses the Wilamette river, Oregon slough and Columbia river to Vancouver, Wash., 10 mi., which is the end of double track. From this point, the single-track Vancouver division extends east along the north bank of the Columbia river to Wishram, Wash., 96.1 mi., which is the end of the First subdivision. The line then extends 123.1 mi. east to Kennewick, Wash., the end of the Second subdivision, and from there the line again crosses the Columbia river to Pasco, Wash., 2.1 mi. From Pasco, the railroad follows the north side of the Snake River Canyon for 37.8 mi. to Farrington, Wash., from which point the line crosses relatively flat country to Spokane. This portion of the route is the Third subdivision.

Character of Route

In the 377.5 mi. between Portland and Spokane there are 19 tunnels which vary in length from 122 ft., to 2,494 ft., and 381 curves, the maximum curvature of which is 3 deg. The ruling grade eastward is 0.2 per cent ascending from Portland to Pasco, and 0.4 per cent ascending between Pasco and M.P. 358, between Mock and South Cheney. From M.P. 358, which is on a 2,327-ft. summit, the ruling grade eastward to Spokane is 1 per cent descending. The maximum ascending grade anywhere between Portland and Spokane is 1.0 per cent westbound from Spokane to Overlook, 8.2 mi.; so, generally speaking, the grade over the entire route is favorable.

The particularly rugged territory, insofar as grades, curves and terrain are concerned, is on 10.6 mi. between Mt. Pleasant and Skamania, and on 26 mi. between Home Valley and Lyle, on the First subdivision; on 23.5 mi. between Votaw and Kahlotus, and 7.5 mi. between South Cheney and



The signals on this project are the Type SA searchlight. View shows a typical single-intermediate signal location. Note slide protection in the background

pancy in the station block and approaches to the sidings, which is an advantage where sighting is short due to curves, fog or other obstructions. The slide-detector fences result in signals displaying their most restrictive aspects in the event of slides, which occur mostly during the rainy months of the year, thus resulting in considerably increased safety to train movements through slide areas.

Extent of Signaling

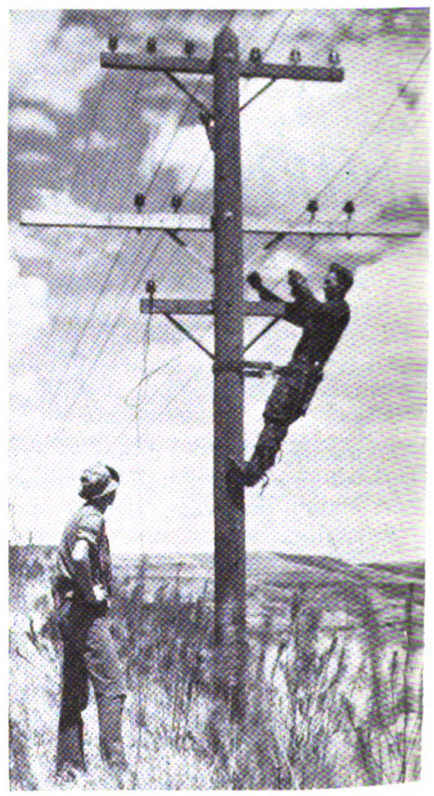
The automatic block installed is all on single track and includes 104.3 mi. between Vancouver and Maryhill, 5.1 mi. between Finley and Kennewick, 27 mi. between Redd and Kahlotus, and 11 mi. between South Cheney and Overlook, all shown in Fig. 1. Prior to the installation of the signaling, the trains were governed by manual block, timetable and train orders. The station-protection signaling includes station-entering signals and distant signals in approach thereto at both ends of 12 passing tracks between Cliffs and Finley, on the Second subdivision, and at 8 passing tracks between Sperry and Mock and 2 at Levey and Scribner, on the Third subdivision. The roughest territories on the route are through the gorge of the Columbia river, between Mt. Pleasant and Lyle, and in the Snake River and Devils Canyons, between Votaw and Kahlotus. These are characterized by numerous curves, rock and dirt cuts and high rocky bluffs, and where the majority of slides occur during the rainy season. Consequently, when the signaling program was planned, attention was devoted to these areas, in order to provide protection there before making installations elsewhere.

The Traffic

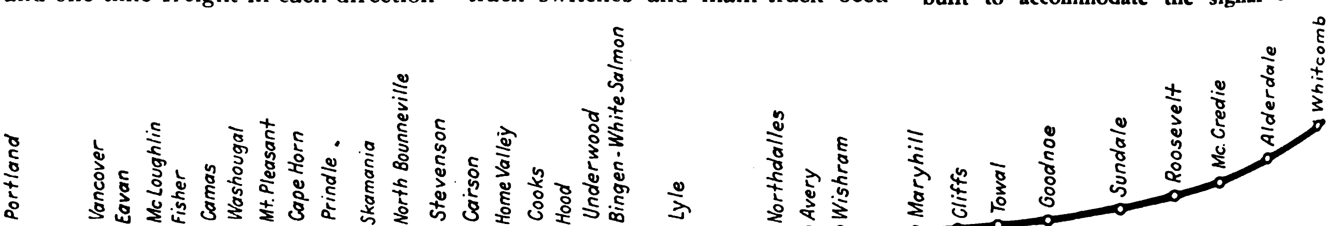
The traffic varies on the three subdivisions. For instance, between Portland and Wishram there are three passenger and two time freight trains in each direction daily, as well as a local freight train in each direction daily except Sunday. On the Second subdivision between Wishram and Pasco there are three passenger trains and one time freight in each direction daily. There are two passenger trains and one time freight in each direction daily, as well as a local freight in each direction three times a week, on the Third subdivision between Pasco and Spokane. Extra trains are operated as required. In addition some tonnage freight trains of the Northern Pacific are operated eastbound over the S.P. & S. between Pasco and Spokane.

Advantages of Signaling

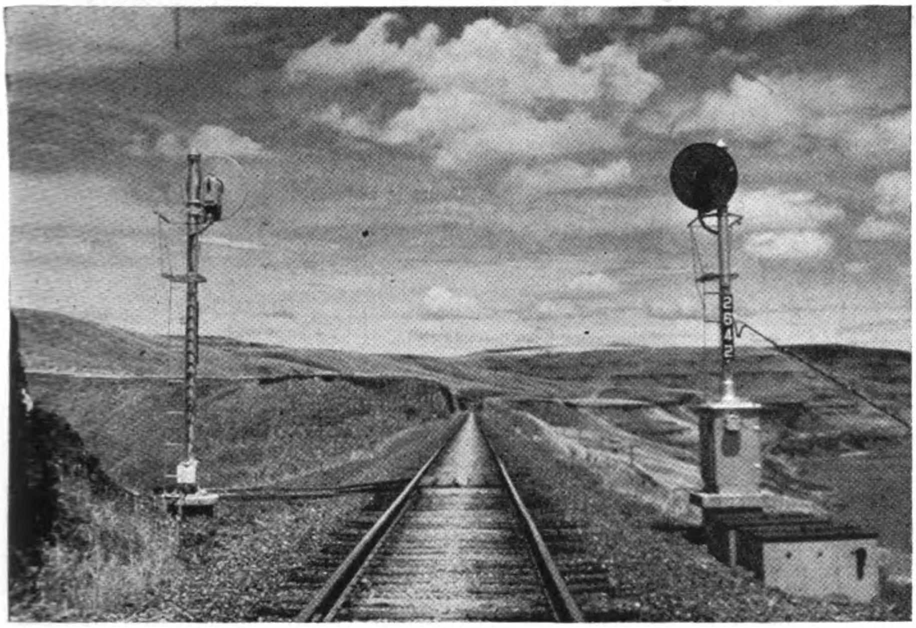
The new signaling as a whole, including the slide fences, has resulted in a general improvement in operation. The new automatic signaling provides increased protection against broken rails, open switches and track occupancy. It is of particular advantage with the numerous curves in the railroad, and also where it parallels the Columbia and Snake rivers, where fogs prevail during certain seasons. The station-protection signals provide information for enginemen in that they check the position of passing track switches and main-track occu-



The existing communications line was rebuilt to accommodate the signal circuits



Map of the Spokane, Portland & Seattle



A typical double-intermediate signal location between Burr and Farrington

Martindale on the Third subdivision.

Included in the signaling program was the installation of 44,810 ft. of slide-detector fences. These are of three types to provide the most efficient protection under different local terrain conditions. They include the overhead, side-wall and woven-wire types. The overhead and side-wall fences are designed primarily for protection against falling rocks. The woven-wire fences are designed primarily for protection against rolling rock. Side-wall and overhead fences are sometimes used together, while in other places the overhead type alone is used. In some instances just the side-wall type is used, while in others a combination of side-wall and woven-wire are used.

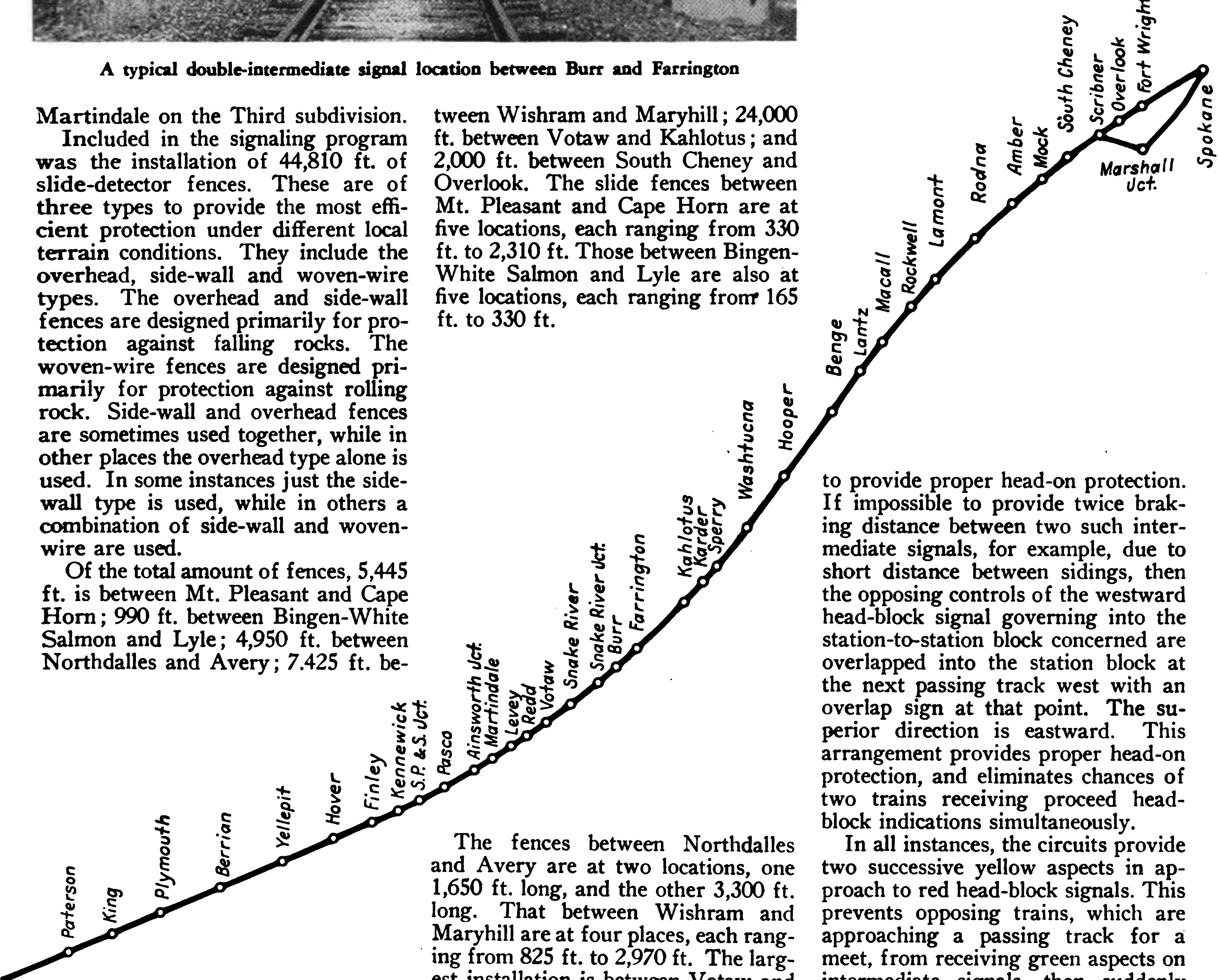
Of the total amount of fences, 5,445 ft. is between Mt. Pleasant and Cape Horn; 990 ft. between Bingen-White Salmon and Lyle; 4,950 ft. between Northdalles and Avery; 7.425 ft. between Wishram and Maryhill; 24,000 ft. between Votaw and Kahlotus; and 2,000 ft. between South Cheney and Overlook. The slide fences between Mt. Pleasant and Cape Horn are at five locations, each ranging from 330 ft. to 2,310 ft. Those between Bingen-White Salmon and Lyle are also at five locations, each ranging from 165 ft. to 330 ft.

The fences between Northdalles and Avery are at two locations, one 1,650 ft. long, and the other 3,300 ft. long. That between Wishram and Maryhill are at four places, each ranging from 825 ft. to 2,970 ft. The largest installation is between Votaw and Kahlotus, 23.5 mi., in the Snake River and Devils Canyons, which includes 18 locations, totaling 24,000 ft.

The signaling at the end of each passing track in automatic block territory consists of a station-entering signal and a head-block signal, located about 40 ft. ahead of the siding switch. An interesting feature is that all head-block signals are permissive signals rather than absolute signals. The sidings average 5,900 ft. in length and are spaced about 6 mi. apart. The intermediate signals are spaced for maximum track capacity with more than braking distance between signals where possible. Where there are two or more sets of intermediate signals, which would occur in a station-to-station block 4 mi. or longer, the locations are double. In such instances the opposing controls of head-block signals are to the opposing head-block signal, and following controls are from block to block.

Where there is only one set of intermediate signals, these signals are staggered at least twice braking distance to provide proper head-on protection. If impossible to provide twice braking distance between two such intermediate signals, for example, due to short distance between sidings, then the opposing controls of the westward head-block signal governing into the station-to-station block concerned are overlapped into the station block at the next passing track west with an overlap sign at that point. The superior direction is eastward. This arrangement provides proper head-on protection, and eliminates chances of two trains receiving proceed head-block indications simultaneously.

In all instances, the circuits provide two successive yellow aspects in approach to red head-block signals. This prevents opposing trains, which are approaching a passing track for a meet, from receiving green aspects on intermediate signals, then suddenly receiving red aspects on the station-entering signals. This feature, however, is not new and has been used for years in this type of signaling. The signals are controlled by A.P.B. three-wire polarized line circuits, including a common and one wire for controlling

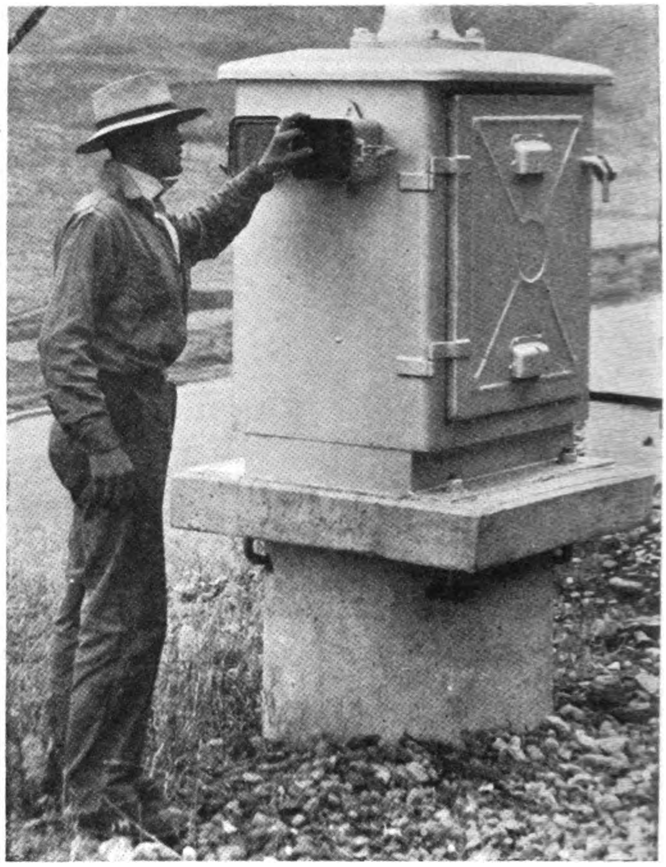


between Portland and Spokane

the signals in each direction. The track circuits are the d.c. neutral type, averaging 3,500 ft. in length.

Station-Protection Signals

A typical installation of station-protection signaling is shown in Fig. 2; the track and signal layout at Paterson, 180.5 mi. east of Portland. The protection at each siding includes a two-position, red-and-green, station-entering signal on the main line at each end of the siding, shown as signal 1792 and 1805. Train movements up to these signals are governed by three-position, red, yellow and green, distant signals, usually spaced full braking distance, plus medium speed braking distance, in approach to the station. In this case, these signals are those numbered 1778 and 1821.



Maintainer operating push-button at an approach-lighted intermediate location to light the signal, so he can check condition of the block. All approach-lighted signal locations have a push-button

The controls of the station-entering signals are overlapped to the opposing distant signal approaches, and the controls of the distant signals are overlapped to the opposing station-entering signals in order to prevent two opposing trains from accepting proceed aspects simultaneously, and to maintain proper braking distance between following trains. For example, the controls for eastward station-entering signal 1792 extend to the approach section (not shown) for westward distant signal 1821, and the controls for the westward station-entering signal 1805 extend to the approach section (not shown) for eastward distant signal 1778. The controls for eastward distant signal 1778 extend to the opposing westward station-entering signal 1805, while those of the westward distant signal 1821 extend to the opposing eastward station-entering signal 1792. These signals are arranged so that if automatic block is installed through the territory at a later date, they can be incorporated without moving them and with few changes in the circuits.

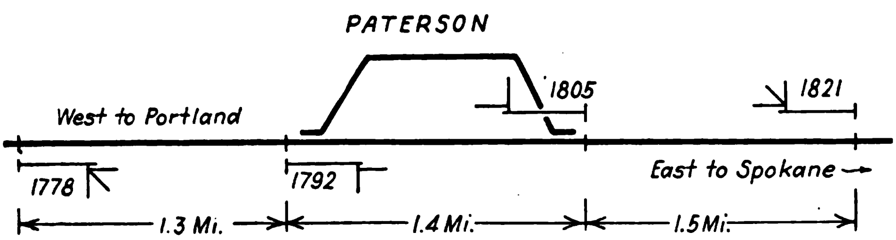


Fig. 2—Typical layout of station protection signaling at Paterson, Wash.

Operation of Signals

Assuming that all signals are clear, when an eastbound train arrives in the approach section (now shown) for signal 1778, the westward station-entering signal is placed at Stop-and-Proceed, and the westward distant signal 1821 at Approach. When the train passes the eastward distant signal 1778, that signal assumes the Stop-and-Proceed aspect. As the train passes the eastward station-entering signal 1792, that signal is changed from Clear to Stop-and-Proceed. Signal 1792 remains red and signal 1778 yellow until the train has cleared the approach section for the westward distant signal 1821, after which they again assume the green aspect for Clear, unless a siding switch has been thrown and a train is leaving the siding. Signals 1805 and 1821 assume their normal aspects behind the train, unless there is a following train or a siding switch has been thrown to allow a train to enter the main track. The cycle of operation for a westbound train is similar to that for an eastbound train.

Spring Switches

The end-of-double track layout at Vancouver, Wash., shown in Fig. 3, prior to the signaling program, included a spring switch on the main line, normally lined for the westbound track, and automatic signals 102 and 103, which have been continued in service. There is also a lead from the westbound main to the S.P. & S. freight yard, which was equipped with a hand-throw stand. As part of the program, this switch was equipped with a spring mecha-

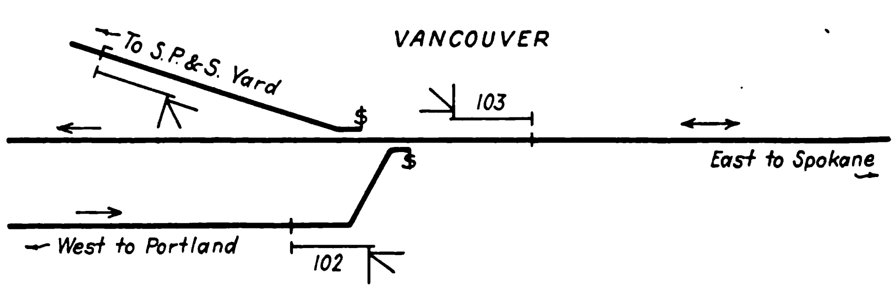


Fig. 3—End-of-double track layout at Vancouver, Wash.

nism, and a three-aspect automatic high signal was installed to govern train movements from the lead to the main line. This arrangement enables freight trains to pull out on the main line and continue eastward without having to stop to restore the switch to its normal position, thus saving several minutes.

A spring mechanism was also installed on the hand-throw switch at the east end of Votaw, shown in Fig. 4, 22.7 mi. east of Pasco. There are many meets at this location, and the spring switch saves eastbound freight trains several minutes when departing from the siding. Signals provided at this location include two-arm, three-indication absolute signals 2544 and 2543 on the main line and a two-indication dwarf signal on the siding. This signal normally displays Stop. When a train is ready to leave the siding, a trainman pushes a push-button, and, after 3 min., the signal clears, authorizing the movement to the main line, providing no trains are approaching from either direction. The spring switch mechanisms used at these various locations were furnished by the Pettibone Mulliken Corporation.

Electric Locks

At Snake River Jct., 25.6 mi. east of Pasco, there is a junction with the Northern Pacific's Snake River branch, as shown in Fig. 4. As part of the project, an electric lock was installed on the main-line hand-throw switch which leads to the branch. Signals governing movements over the switch include 2566, 2567 and 2569, each of which consists of two arms. Signals 2566 and 2567 display red, yellow or green-over-red for Stop, Approach or Clear, respectively. Signal 2569 on the Northern Pacific displays red-over-red, yellow or green for Stop, Medium-Approach or Medium-Clear, respectively. When a Northern Pacific train is to leave the branch, a trainman pushes a push-button, which knocks down all signals governing movements over the switch to Stop. After a 3-min. time interval, and providing no trains are approaching on the S.P. & S., the electric lock is released and the switch may be thrown. Signal 2569 clears according to block conditions.

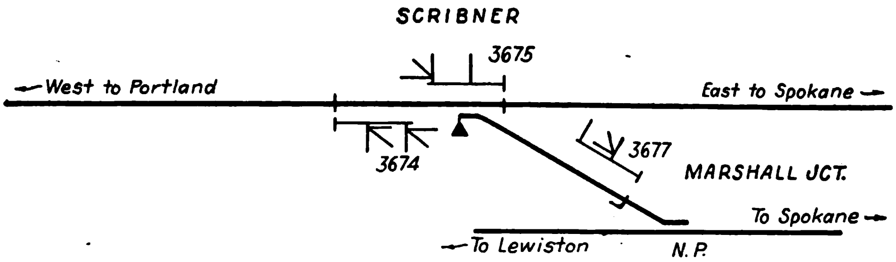
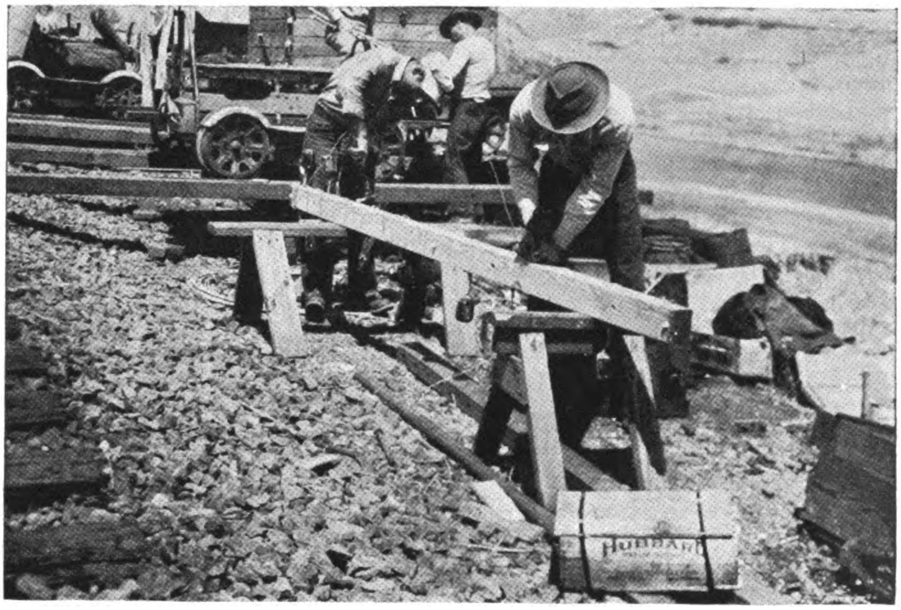


Fig. 5—Track and signal layout at Scribner

A similar arrangement is in service at Scribner, 8.7 mi. west of Spokane, shown in Fig. 5, where a connecting track leads from the S.P. & S. main line to the Northern Pacific's main line between Lewiston, Wash., and Spokane. Protecting signals include 3674 and 3675 on the S.P. & S., and 3677 on the N.P. The only difference in this layout, compared with the layout at Snake River Jct., is signal 3674, which has an operative second arm. This signal will display red-over-yellow for Medium-Approach when the switch has been unlocked and lined for a facing-point movement from the S.P. & S. to the N.P. connection, and red-over-green if the home signal at Marshall Jct. has been cleared.

The signals on this project are the General Railway Signal Company's Type SA searchlight, equipped with 10-volt, d.c., 250-ohm operating coils and 10-volt, 5-watt single-filament lamps and compound lens assemblies. The units are mounted to the left of the masts 13 ft. above the top of the rail to bring them as much in line with the enginemen's view as possible.



Signal gang constructing slide fences

Junction-box bases are used at the base of the mast in lieu of the standard A.A.R. base, except where base-of-mast instrument cases are in service. Underground cables are terminated in this box, and individual conductors are run inside the mast to the signal head.

Details of Signals

The signals are painted aluminum, except for the front of the backgrounds, and hoods which are painted black. Permissive signals are designated by number plates, and absolute signals by the absence of a number plate and the presence of a second operative arm or Type-W fixed red marker, mounted vertically below the top arm. Grade signals are designated by a 15-in. square yellow marker below the signal unit. However, there is only one such signal on the project,

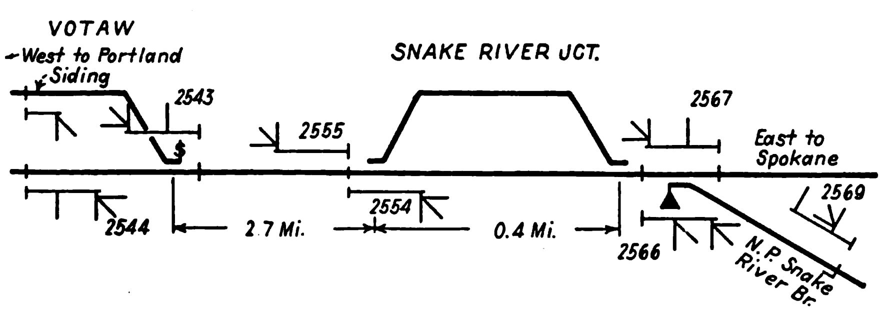


Fig. 4—Track and signal layout between Votaw, Wash., and Snake River Jct.

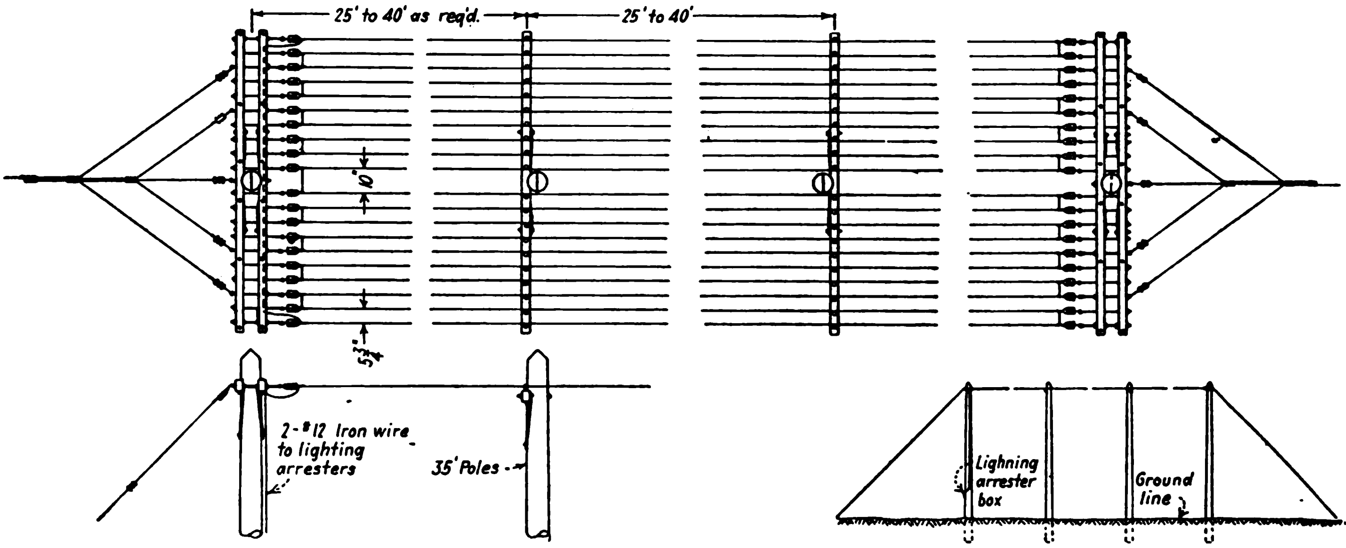


Fig. 6—Diagram showing construction of the overhead type fence

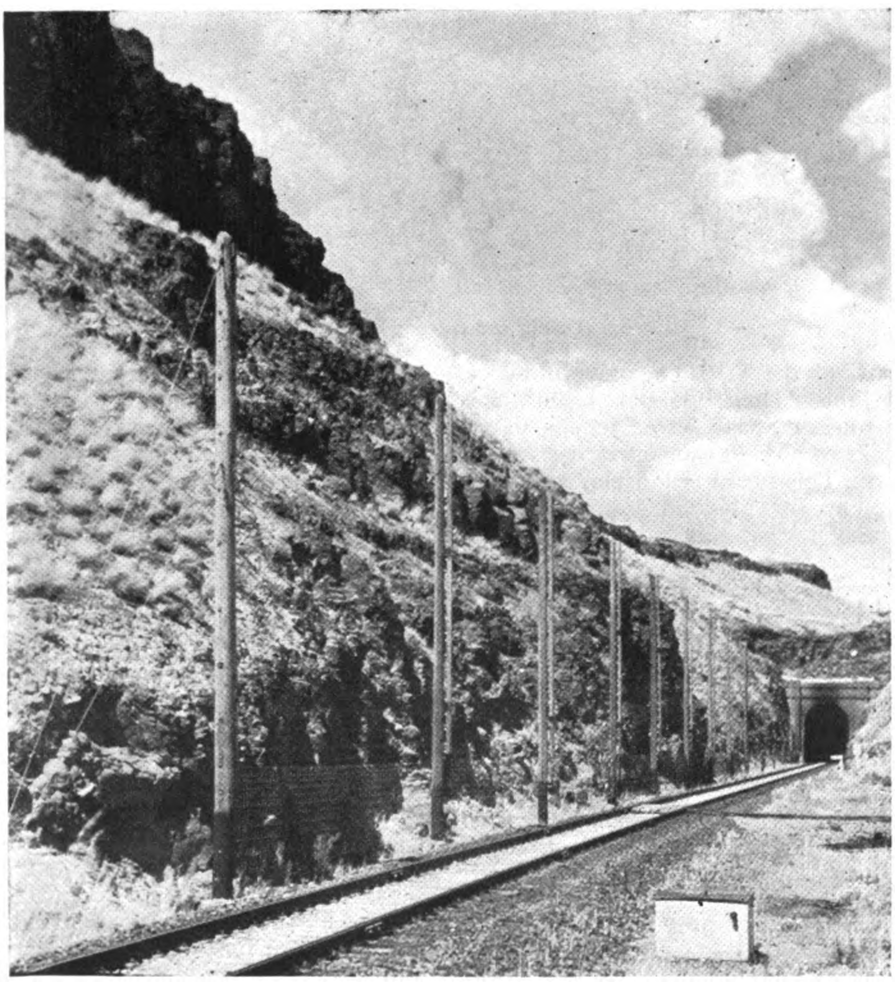
namely at the west end of Tunnel 16, between Farrington and Kahlotus. Signals and instrument cases are mounted on precast concrete foundations.

Construction of Slide Fences

The slide-detector fences are of three types to meet local terrain conditions. These are the overhead, side-wall and woven-wire fences, the construction of which will be covered briefly in the following paragraphs. The construction of the overhead type fence is shown in Fig. 6. This type of fence is mounted on 10-ft. crossarms at the top of 35-ft. poles, spaced 25 to 40 ft. as required. The fencing consists of No. 12 BWG iron insulated weatherproof wires, spaced 12 in. apart, and strung back and forth on the crossarms to form a series circuit. The crossarms are mounted on the poles at any angle required to meet local terrain conditions.

Single crossarms with standard insulators are used on the intermediate poles. The end poles are guyed and double arms are used to end the wires on strain-type insulators. At either end of the fence section, two leads to the series circuit of the fence are extended down the pole to a junction box. The circuit then extends to the fence relay which controls the signals and which will be discussed later. This type of fence is primarily for falling-rock protection, and is particularly applicable where a high bluff parallels the track, and rocks drop straight down on the railroad.

The construction of the side-wall fence is shown in Fig. 7. This type of fence is applicable in deep cuts where rocks have a tendency to fall on the railroad from a side angle, rather than directly downward. The wires of the fence form a series circuit, as in the overhead type fence, and are strung back and forth one over the other 6 in. apart on crossarms which are bolted to the poles. Porcelain knobs are used at the intermediate poles, and the wires are dead-ended on strain insulators at the end poles, which are guyed. As can be seen in the drawing, as many as 2½ panels of this fence may be placed above each other to meet local requirements. The poles are 35



Typical installation of combination side-wall and woven-wire type (at the bottom) of slide fences

ft., spaced from 25 to 40 ft. as required, being set in the ground 5 ft.

Woven-Wire Fence

The woven-wire fence, which is designed to provide protection primarily against rolling rock, is shown in Fig. 8. It consists of No. 9 iron wire meshing 56 in. high, mounted on 6-in. by 6-in. by 9-ft. 10-in. square wood posts, set 3 ft. in the ground. The meshing is loosely stapled on the intermediate posts, but securely stapled at the end posts. The posts are spaced 50 ft., and tension is maintained on the fence by springs at one end. Signal circuits are controlled by Pyle-National plug couplers, operated by chains tied to the fence as shown. Two pins and insulators are provided on top of the fence posts for running the control circuits to the plug couplers.

Each slide fence operates a fence relay located at the nearest signal, and when de-energized, causes those signals on each side of the slide to assume the red aspect, and signals in approach thereto, the yellow aspect. The control circuits for the fence relay are 10 volts. On the side-wall and overhead fences the circuit, which goes through the fence, is opened when a rock breaks a wire, which causes the fence relay to drop. On the woven-wire type fence, the circuit is opened when any coupler is pulled due to pressure on the fence when struck by rolling rock.

Power Supply

At each signal where a.c. power is available, there is a set of five cells of Exide KXHS-7 storage battery on floating charge from a BT-116 copper-oxide rectifier. At double locations, however, there is only one power-off relay and one lighting transformer which serve both signals. Where a.c. power is not available, a set of 16 cells of Edison type 1,000-a.h. primary battery is in service for the line circuits and signal controls. Each track circuit is fed by two cells of Edison 1,000-a.h. primary battery in multiple on the straight primary system. The track relays are the Type K, rated at 4 ohms. Signals, where a.c. power is available, are continuously lighted, but at primary battery locations they are approach lighted. Head-block signals are back lighted with the signal red and the YGP relay down.

Pole Line Reconstructed

The existing telegraph and telephone line was reconstructed to accommodate the new signal line control circuits and power circuit where a.c. is available. The line control circuits are on weatherproof No. 9 iron wire on a new 10-ft. 10-pin untreated fir crossarm under the communication wires on the pole line. Ohio Brass Company brown glazed poreclain insulators and steel pins are used. The power circuit, where in service, is on the same crossarm, and consists of two

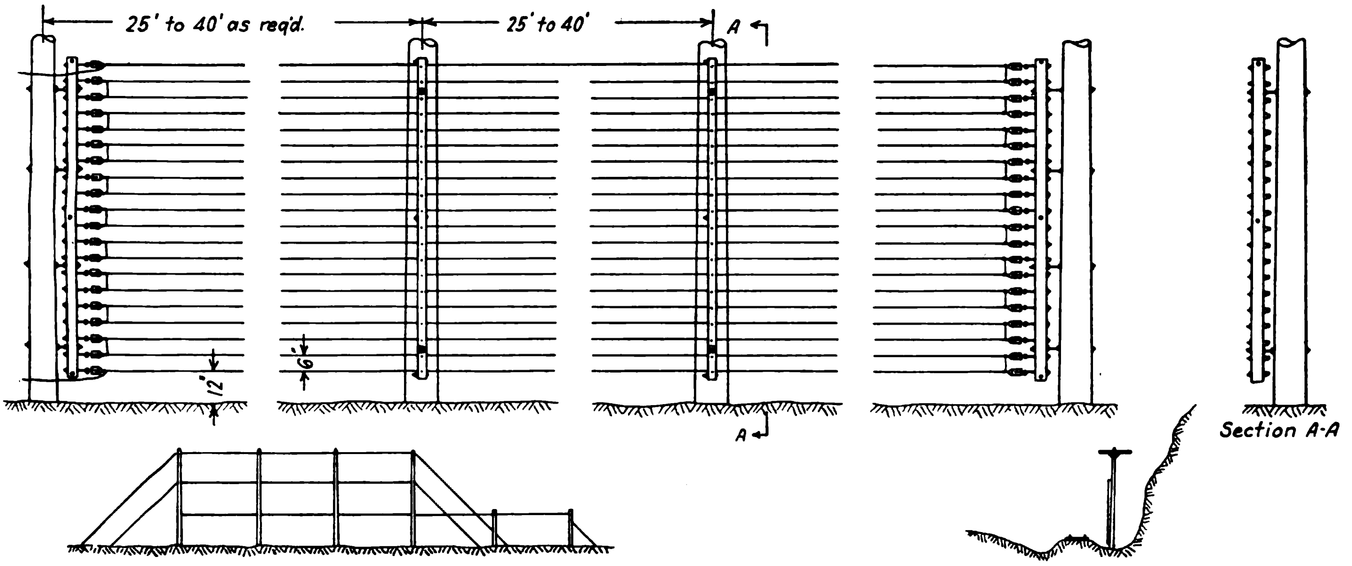


Fig. 7—Diagram showing the construction of the side-wall type fence

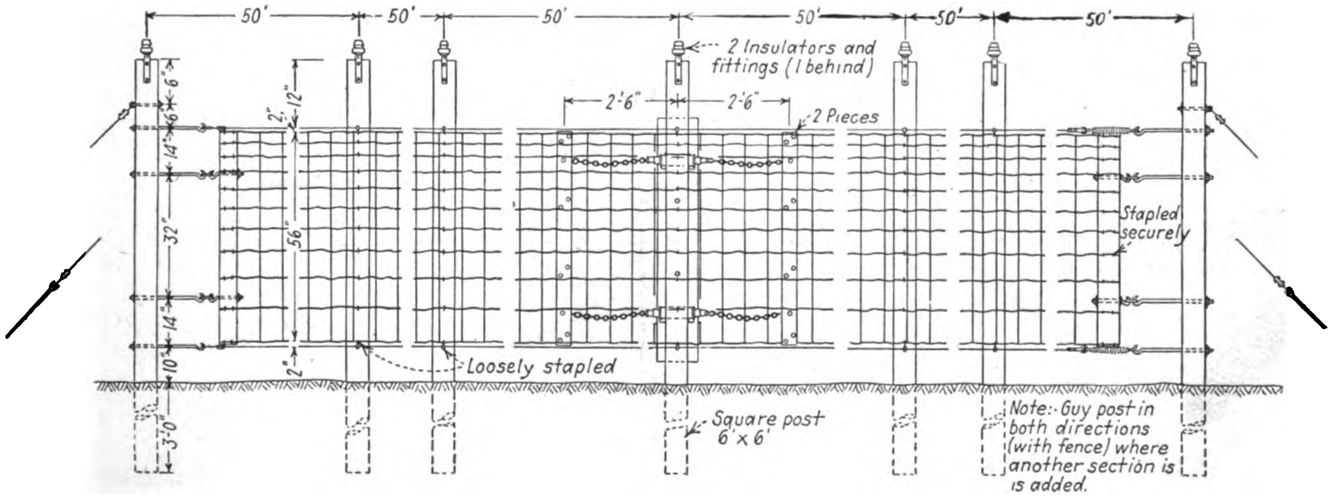
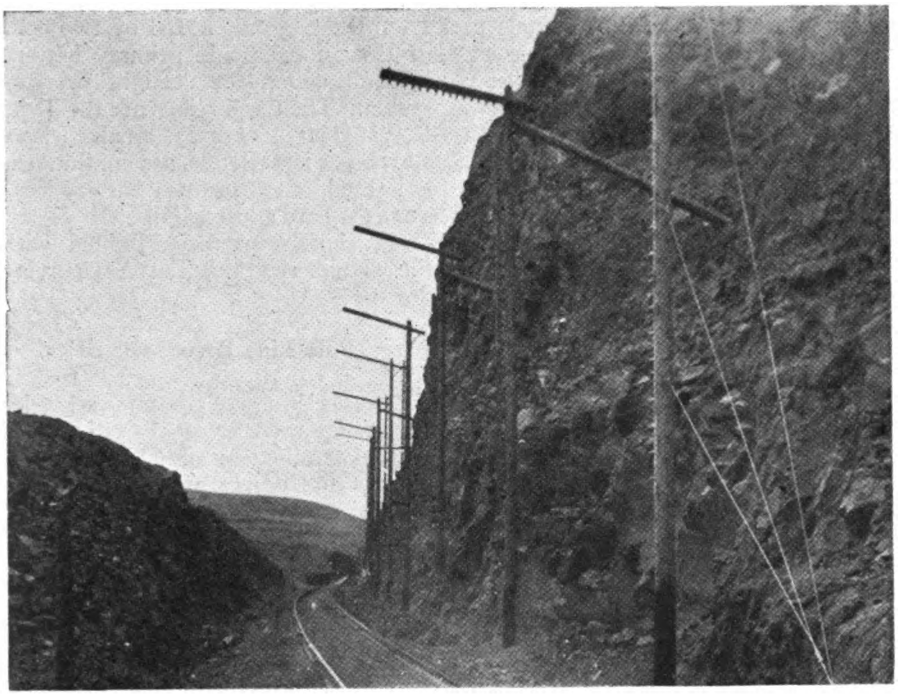


Fig. 8—Diagram showing the construction of the woven-wire type slide fence



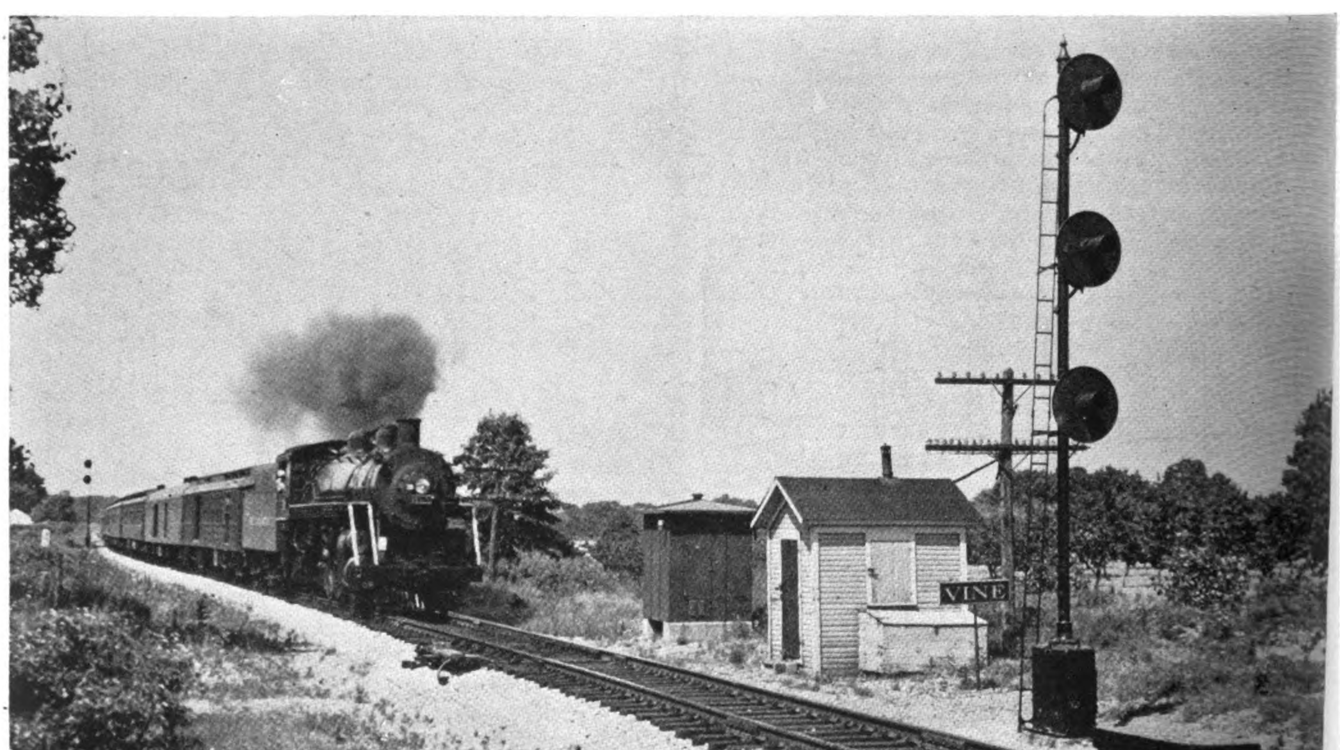
Cut between Farrington and Kahlotus, on the Third subdivision, showing the overhead and the side-wall types of slide fence

No. 8 weatherproof copper wires. A power circuit is in service from McLoughlin to Mt. Pleasant, 17.7 mi., at North Bonneville and Stevenson; from Northdalles to Maryhill, 20.3 mi.; and from Finley to Kennewick, 5.1 mi. Line breaks on all circuits are made with Line Material Company dead-end shackles.

Connections to track circuits are in Simplex single-conductor No. 9 underground parkway cable with no metallic armor. Line drops are in aerial cable made of No. 14 solid soft-drawn rubber-covered copper wire, suspended from ¼-in. S. & M. galvanized iron guy strand with Davison cable clamps. Inside case wiring is No. 16 flexible. Ground rods are the Copperweld type, 8 ft. long, with set-screw clamps for ground wire connections. The line-wire splices are made with Nicopress sleeves, furnished by the National Telephone Supply Company. The rail is 90 and 112-lb. stock, bonded with Ohio Brass O-B hammerhead rail-head bonds. Frogs are bonded with 11-ft. Copperweld bonds with a ⅜-in. plug. Similar bonds are used for fouling circuits, in which case double bonding is used. The switch circuit controllers are the G.R.S. Model 7. Lightning arresters on all line circuits are the Raco Clearview type.

Sheltering of Apparatus

The signal apparatus, such as relays, rectifiers, resistances and other equipment at signal locations is sheltered in a low double-door, base-of-mast, welded-steel instrument case on the pole-line side of the track. The relays are the Type K. The major items of signaling equipment were furnished and installed by the General Railway Signal Company. The rock slide fences were installed by the railroad forces.



In centralized traffic control territory on the Pere Marquette