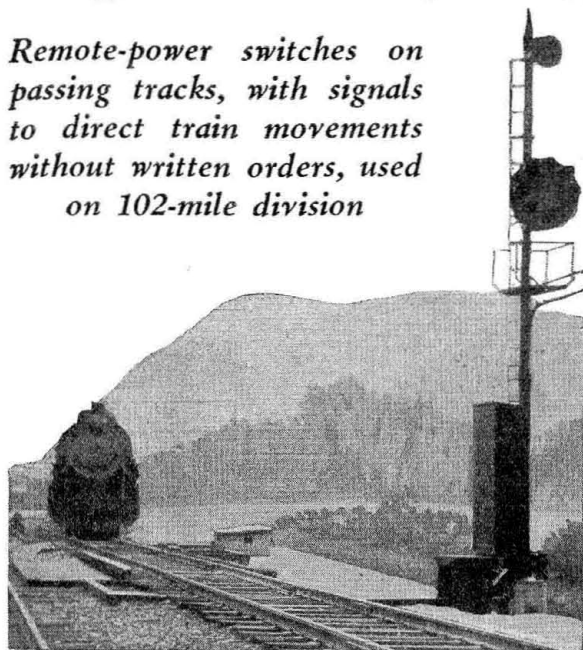


Trains on Baltimore & Ohio

Operate by Signal Indication

Remote-power switches on passing tracks, with signals to direct train movements without written orders, used on 102-mile division



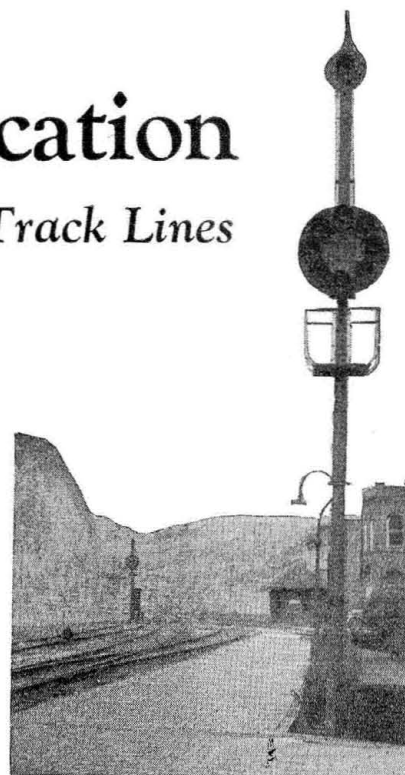
Over Single-Track Lines

By G. H. Dryden

Signal Engineer,
Baltimore & Ohio

Left—West bound freight train leaving the siding at Salem, W. Va.

Right—View near Salem station looking east over switches at the lap



THE Baltimore & Ohio has recently completed a system of signaling and remote control power switches on a complete division between Grafton, W. Va., and Parkersburg, a distance of 102 miles, of which 89 miles is single and 13 miles is double track. Between these limits all train movements are being directed by signal indication without written train orders, and train stops to enter or leave the passing track switches are eliminated. All signals are the color-position-light type, and the switch machines are electrically operated. The system is controlled from desk-lever machines located at 16 points along the division, principally at existing interlockings or important telegraph offices. The installation was constructed by signal department forces of the Baltimore & Ohio.

Track Layout and Physical Limitations

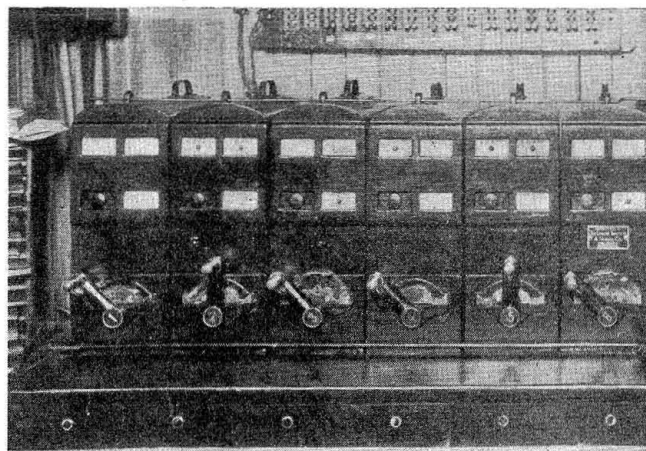
Extending westward from Grafton to Rosemont, there is an 11-mile section of double track which is signaled for regular movements on the right-hand track. Through Clarksburg there is a two-mile section of

double track between interlockings "MO" and "J"; likewise there is a one-mile section of double track from Camden into the yard at Parkersburg. The remainder of the division is single track, with lap siding layouts at 11 stations and single sidings at 3 other stations, as shown on the track plan. At the end of double track and at all passing siding inlets or outlets, interlocking is provided, each interlocked switch being protected by signals near the fouling point.

This division traverses a mountainous section of West Virginia with numerous curves, grades and tunnels.



Signaling on the double track west of Grafton



The desk-levers are placed on heavy wooden tables

The ruling grades vary from 0.96 to 1.47 per cent. There are 23 tunnels on this division, varying from 300 to 2,710 ft. in length, the longest being located near Clarksburg, W. Va.

This division is a part of the Philadelphia-Cincinnati main line and handles nine passenger trains each way daily, including the National Limited, while the freight traffic includes approximately 11 trains each way daily. Approximately 40 trains are, therefore, operated over this line daily. The through passenger trains are sched-

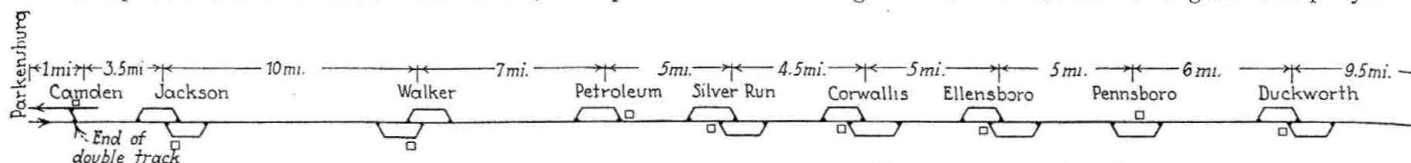
uled to traverse the 102 miles in about 3 hr. 7 min., and the through freight trains in about five hours.

All train movements are directed by signal indication without written train orders. When an approaching train operates an annunciator in a station, the operator

of orders, and materially reducing the number of train hours.

The Control System

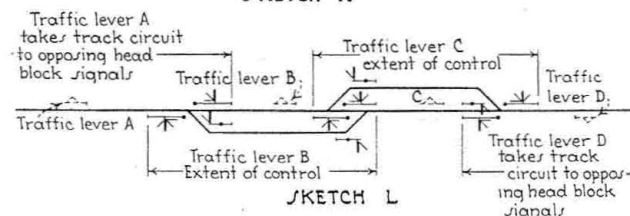
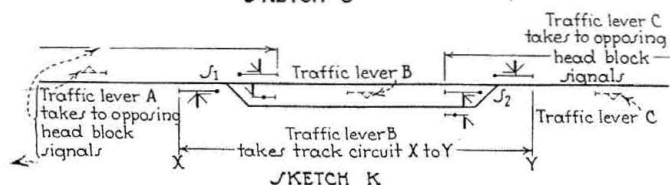
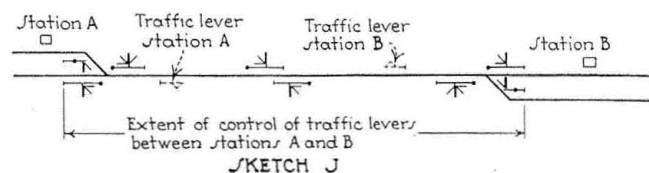
The switches and signals are controlled by table-lever interlockings of Union Switch & Signal Company's



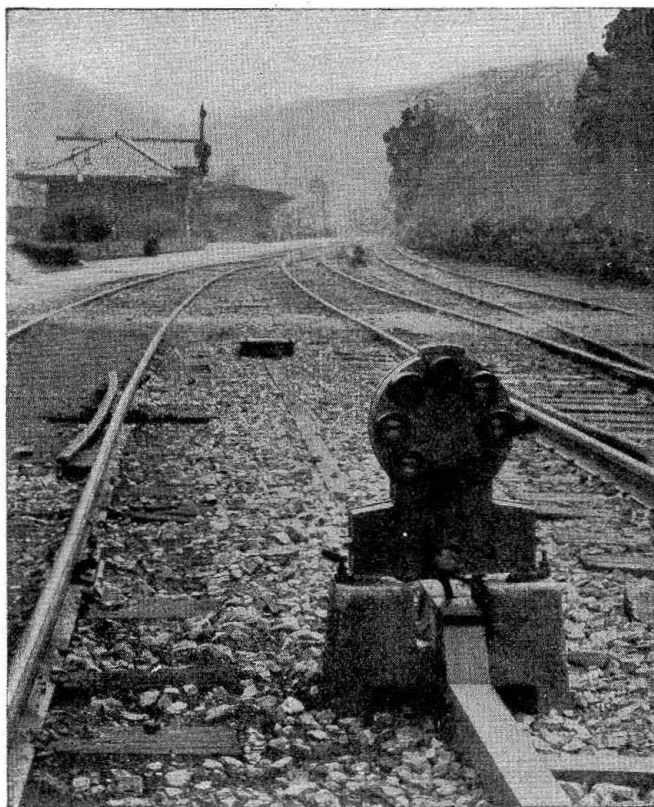
Track plan showing the location of the passing siding

informs the dispatcher, who then directs the operator to allow the train to proceed on the main track, or to take siding. The control system is, therefore, centralized in that the dispatcher directs each movement, yet at the same time the system is very flexible in that the operator has direct control of the switches and signals in the immediate layout, and can operate these facilities to meet the existing requirement without delay. Likewise, in lining up the signals to direct a train movement from one station to another, the dispatcher issues instructions that the move is to be made, but the two operators must co-operate in the operation of the locking features in order that the proper signal will be displayed.

This system of control was installed on this division because it provides the highest degree of protection, and



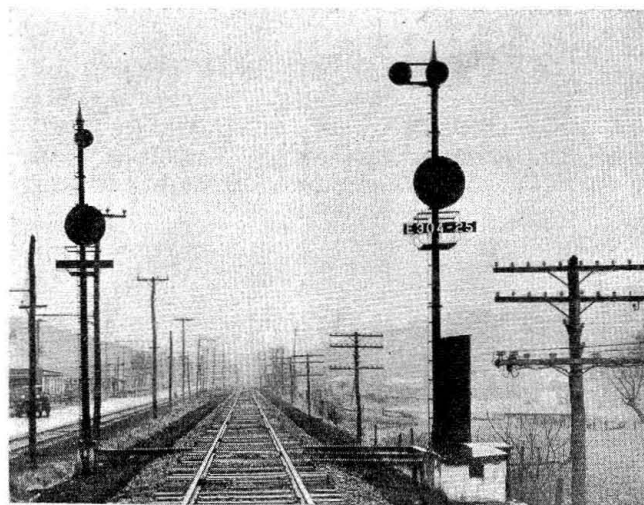
Diagrams showing extent of control



Each dwarf signal is a miniature of a high signal

is similar to previous installations made on the Baltimore & Ohio system. The majority of the stations where the control machines are located were existing interlocking plants or important block offices. This installation, combined with its remote control of all passing siding inlets, outlets and ends of double track, is part of the program of expenditures to increase safety and track capacity, and also to reduce operating costs. It provides a means for keeping trains moving at closer intervals, thus avoiding stops caused by the issuance

of orders, a 7-lever unit being required at a single passing siding, and a 12-lever unit for a double passing siding. These interlockings are equipped with switch, signal and traffic lever control at each station. The switch and traffic levers operate in two positions. The signal levers are in the central position normally, and operate to the left for trains in one direction and to the right for trains in the opposite direction. The short traffic levers must be moved prior to the clearing of



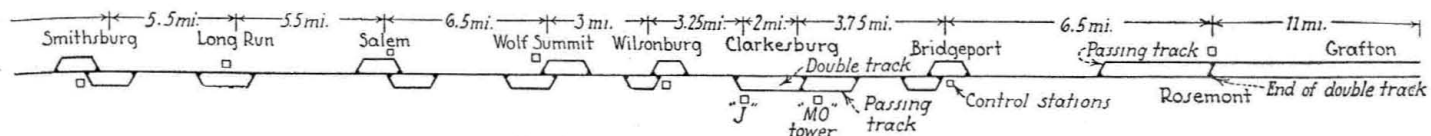
Signaling on single track

signals which govern within passing siding limits. These levers are equipped with electric locks, arranged to lock them in either the normal or reverse position. The reversal of a signal lever, governing trains in one direction,

locks the short traffic lever normal, while the reversal of a signal lever governing over the same track in the opposite direction, locks this lever reversed.

The long traffic levers, which govern over the single-track section from the outlet at one station to the inlet at the next, are electrically locked in the normal position

Sketch K shows the extent of control of traffic levers at a single passing siding. Traffic levers *A*, *B* and *C* are required. Traffic lever *A* locks from the head-block signal at one station to the opposing head-block signal at the next station. Traffic lever *B* includes the zone between opposing home signals as shown. Traffic



tracks in the territory operated by signal indication

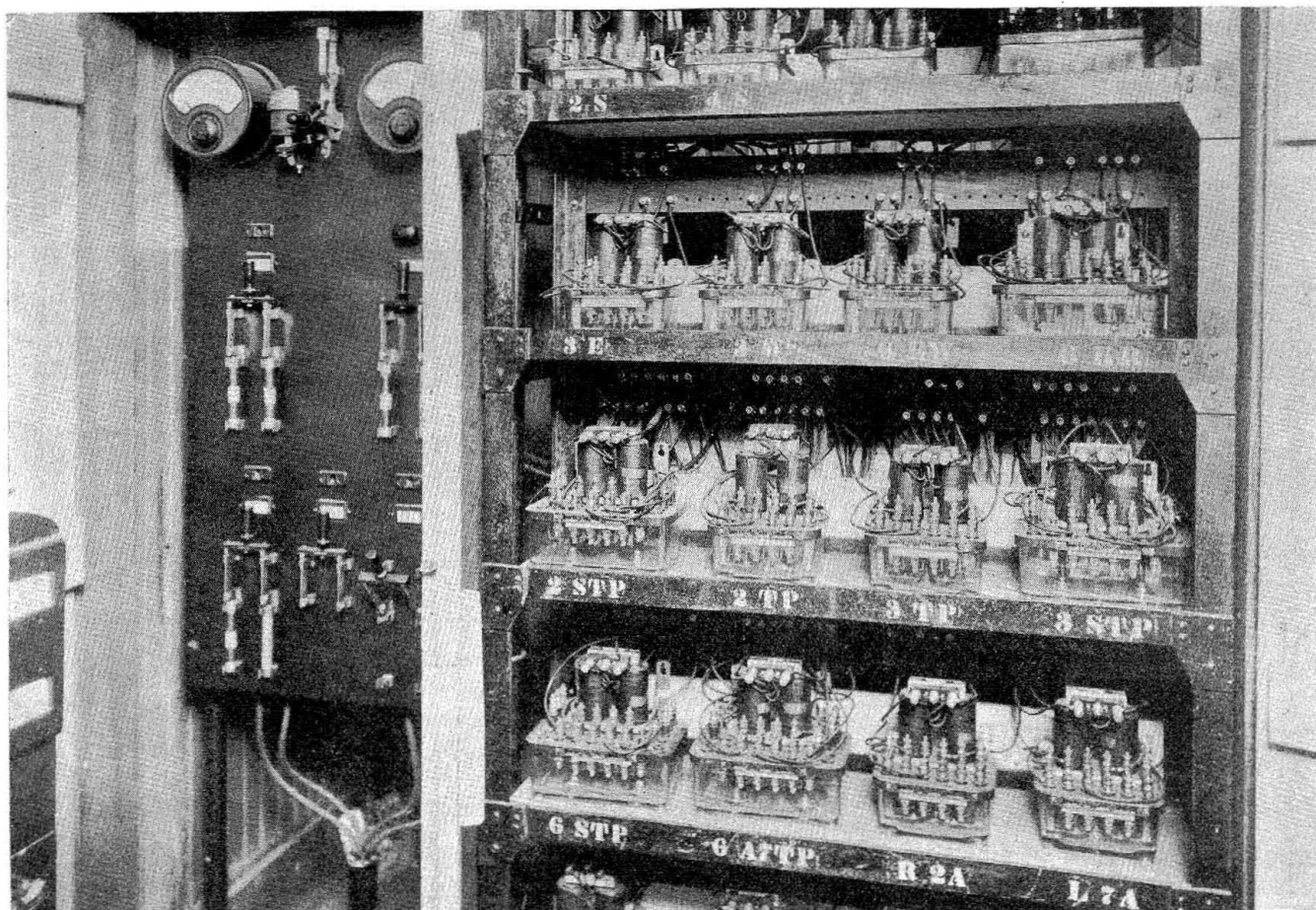
only; they are operated prior to the clearing of a so-called head-block signal, and must be unlocked by the operator at the next station. These levers are also controlled through track circuits and, therefore, cannot be unlocked unless the opposing head-block signals are at stop, all track circuits between being unoccupied and the traffic lever at the next tower being normal.

Sketch J shows the extent of control of traffic levers used for locking between towers, or, from a head-block signal at Station *A* to the opposing head-block signal at Station *B*. These traffic levers (shown *A* and *B*) are each electrically locked normal and are mechanically locked in the reverse position by the outgoing head-block signal. When the long single-track section is occupied, a traffic lever, if reversed, may be placed in the normal position, but after being placed in the normal position it is locked in that position until the track circuit between opposing head-block signals is clear, after which traffic lever *A* may be reversed if unlocked by lever *B*, or traffic lever *B* may be reversed if unlocked by Station *A*.

lever *C* takes the track circuit from the head-block signal to the opposing head-block signal at the next station.

Sketch L shows a lap siding layout which requires four traffic levers shown as *A*, *B*, *C* and *D*. Traffic levers *B* and *C* are equipped with electric locks which lock the lever in both the full normal and full reverse position. The sketch indicates the extent of control of each traffic lever in which it will be noted that there are certain overlapping features. The traffic lever at interlockings in each case takes all track circuits between opposing signals which govern over the same block.

Automatic signals spaced from 5,000 to 6,000 ft. apart are located between opposing head-block signals to insure proper spacing of following trains. These automatic signals are controlled on the A. P. B. principle, added to which are special circuits for the control of the "stop and proceed" indication, the arrangement being such that for a train following another into an occupied block, a "stop and proceed" indication is displayed. Opposing signals throughout the entire single-track section display the "stop" indication. Trains



The power switchboard and relay racks located in the office at Salem

receiving a "stop and proceed" indication are governed in the same manner as in double-track territory. Stop signals cannot be passed except by order of the dispatcher or when preceded by a flagman

Type of Equipment

All the signals are the Baltimore & Ohio color-position-light type. The high signals are either ground

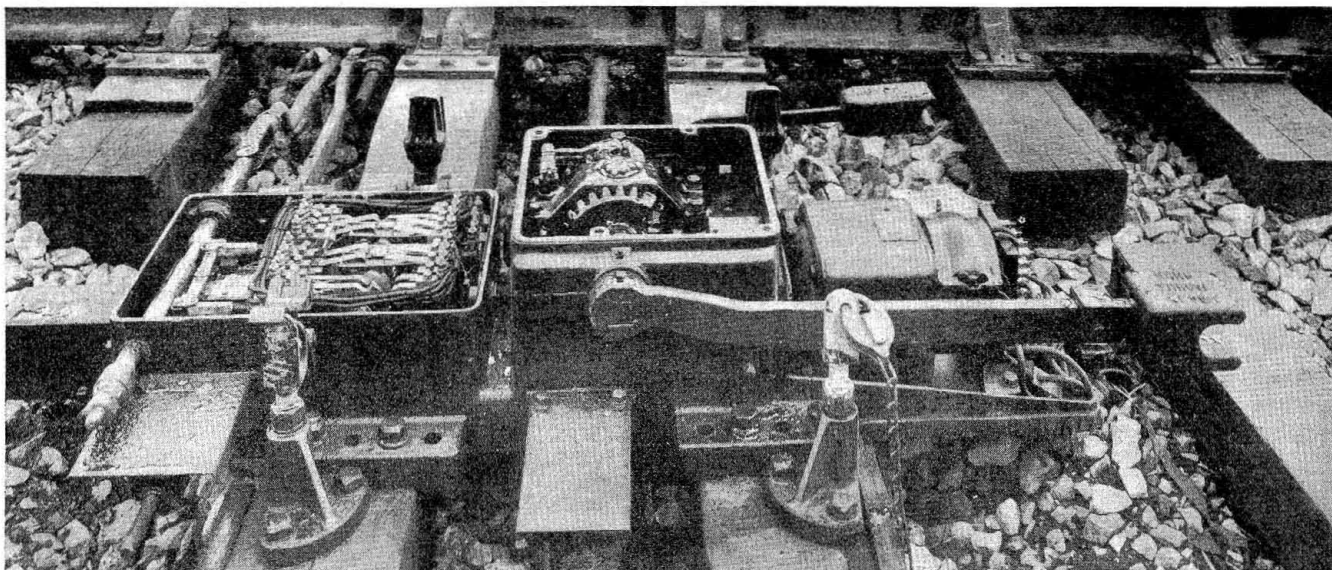
or bracket masts, for the automatics or for interlockings governing movements from main track to main or from main to siding, are of the Union Switch & Signal manufacture, with $8\frac{3}{8}$ -in. lens. The color-position-light signal provides 14 aspects and is readable by color as far as it can be seen and by position from 4,000 to 6,000 ft. Whenever the stop color (red) or the stop position (horizontal) is displayed, trains are required to stop; aspects permitting a train to proceed without stopping are not given in conjunction with the stop color or stop position. Any light failure creates a restriction. The signal provides a three-arm equivalent, each arm operating in four positions. Any signal, whether home or automatic, may be wired to serve both as a stop and as a stop-and-proceed signal. Each individual color has a corresponding position, and this combination of color and position should in no case be misread.

The dwarf signals for governing movements from the passing tracks to the main line are also of the color-position-light type and convey the same information to trains leaving a siding that is provided for main track movements, except that the clear indication is not given. Means are provided to convey the same number of aspects that are provided by high signals; in fact, they are miniature signals of the same design as the high signals and are particularly useful in terminals or at any point where trains are not required to run at high speed. They are the only dwarf signals designed to give the "stop-and-proceed" aspect.

The power switch machines are the Union Type-M 20, while the relays are the General Railway Signal Company Model-K. Lightning arresters are the Railroad Supply Company triple-path type. Storage batteries were furnished by the Electric Storage Battery Company, one 120-a.h. Type-EMGO-7 cell being used for each track circuit, and six 80-a.h. Type-EMGO-5 cells for each line circuit. This battery is used also as a stand-by for the signal lights in case of any failure

of the a-c. supply. Twelve cells of the same type are used for each switch machine. The storage batteries are charged by Fansteel rectifiers with Kuhlman transformers for the charging and lighting voltages and General Electric Type-M transformers on the pole line.

The line wire for the signal control is No. 10 copperweld with double-braid weatherproof covering. For the 460-volt a-c. line, No. 4 copper wire with double-braid



The covers on the switch machines are removable to facilitate inspection

weatherproof covering is used. This wire is carried on porcelain insulators. One new crossarm was added to the existing pole line and the line wires were strung by the Western Union construction forces. Within the

Extent of B. & O. Signaling Installation

Mechanically-operated interlocked derails.....	10
Mechanically-operated interlocked switches.....	22
Electrically-operated interlocked switches.....	56
Hand-operated switches in or leading to main track.....	129
Hand-operated derails protecting foulings.....	92
Seven-lever table interlocking machines.....	5
Twelve-lever table interlocking machines.....	11
Four-position, color-position-light high signals, giving stop, stop-and-proceed, restricting, approach and clear indications.....	63
Three-position, color-position-light high signals giving stop, stop-and-proceed, approach and clear indications.....	146
Two-position, color-position-light dwarf signals giving stop and restricting indications.....	9
Three-position, color-position-light dwarf signals giving stop, restricting and approach indications.....	13
Three-position, color-position-light dwarf signals giving stop, stop-and-proceed, restricting and approach indications.....	8
Two-position, color-position-light dwarf signals giving stop, stop-and-proceed and approach indications.....	49
Highway crossings protected by flashlight signals.....	10

limits of sidings, wires other than for power are carried in aerial cable supported from a $\frac{3}{8}$ -in. copperweld messenger by means of copperweld messenger hangers.

Rail joints are bonded with gas-welded bonds, some of which were furnished by the American Steel & Wire Company and the rest by the Ohio Brass Company. Insulated rail joints are the single-end type as furnished by the Rail Joint Company. The main-track switches are equipped with two switch circuit controllers which are wired with separate bootleg connections for shunting the track circuit. Commercial sidings are protected by derails at foulings, these switches being equipped with one switch circuit controller only for shunting the track circuit.