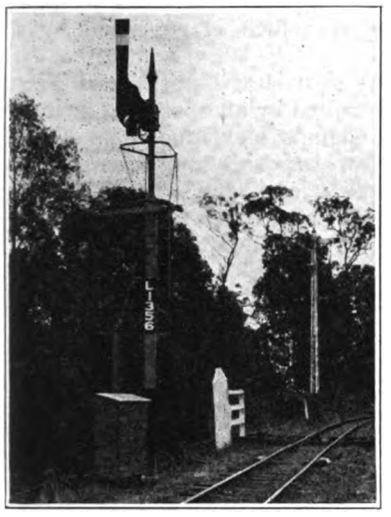

Single Track Signaling in Australia

Operation of Trains by Signal Indication Considered as Safe as the Token System

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THE question of equipping single track lines with automatic signals has had the attention of the signal engineers of the different Australasian government railways for some time. Four Australasian state railway authorities have shown their faith in this system by equipping sections of single line with automatic signals.

Signal Installations Authorized

The New Zealand Government Railways were the first to authorize such equipment, and 11 miles of single line between Upper Hutt and Lower Hutt are being equipped with three-position, upper left-hand quadrant signals, as a continuation of the installing of power and automatic signals on the double track line from Wellington to Lower Hutt, a distance of 9 miles, on which the traffic is exceptionally heavy at times.

Alternating current will be used for both the double and single line signaling; overhead transmission wires, carrying a voltage of 2200 at 50 cycles, with transformers, mounted on the transmission poles, will be installed to reduce the voltage to 110 volts for signal operation and 6 volts for track circuit purposes. The Absolute Permissive Block system of the General Railway Signal Company has been adopted for the single track signaling.

Authority has been given by the railways commissioners of the New South Wales Government Railways for the installation of automatic signals on the 80 miles of single track forming the new deviation between Molong and Dubbo (283 miles from Sydney).

In order to provide for an increased train service, the South Australian Government Railways intend to install three-position, upper left hand quadrant A. P. B. signals on the single track line between Eden and Murray Bridge, a distance of 51 miles, which forms a portion of the main line between Adelaide and Melbourne. At present power and automatic signals are in service on the double track line between Adelaide and Eden, a distance of 9 miles; and several stations on the Eden-Murray Bridge section have been equipped with three-position, upper-quadrant, low-voltage signals which are now in operation. The signals at each end of the latter stations are controlled by four-way rotary switches, placed in the station-master's office, and the same switches control the switch movements by means of electrical locks; the switches in some cases being worked by hand from ground levers. The remaining stations will be provided with power signals and intermediate automatic signals between stations will be installed in due course.

The success that has attended the installation of power and automatic signals on the Melbourne suburban lines of the Victorian Government Railways is reflected in the fact that that Administration is the first to place automatic signals for single track lines into operation in Australia, and, following Canada, is the second country in the British Empire to place such signals in service.

Upper Fern Tree Gully to Upwey Installation

The standard track gage of the Victorian Government Railways is 5 ft. 3 in., but there are some sections of single track of 2 ft. 6 in. gage. One 18 mile section from Upper Fern Tree Gully (23 miles from Melbourne) to Gembrook, carries a heavy tourist traffic and train-staff

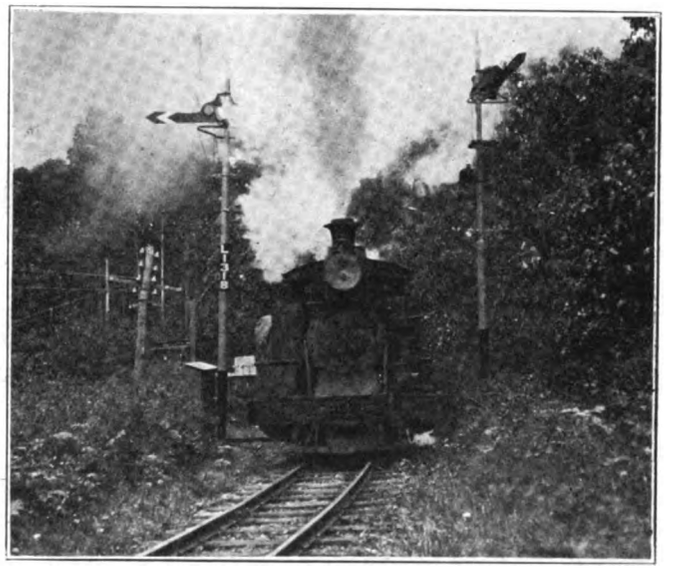


Fig. 1. Intermediate Location, All Signals Operate in the Upper Left-Hand Quadrant and Are Located on Left Side of Track

and ticket working, in conjunction with Winter's single line block instruments was in use.

In order to handle the increasing service is became necessary to provide an additional passing track station at Upwey, 1¾ miles from Upper Fern Tree Gully; and to do this under the then existing circumstances would have required the installation of electric train-staff instruments between Upper Fern Tree Gully-Upwey and Upwey-Belgrave, a total distance of 3½ miles. This method of operation was compared with the provision of automatic signals for the same section, and on the recommendation of the engineer of signals, F. M. Calcutt, the railways commissioners authorized the installation of

three-position, upper left-hand quadrant, low-voltage signals between Upper Fern Tree Gully and Belgrave, using the A. P. B. system with normal danger departure signals and normal clear intermediate and arrival signals. Note from the illustration that signals are set on the left side of the track.

Under this arrangement the standard features of the A. P. B. system are retained, and the directional stick relay is used, with double "Caution" indication for an opposing train; in addition, the departure signals are made normal danger and electrically interlocked one with the other. Overlaps are not provided for following movements, thus following the practice laid down by the Signal section of the American Railway Association.

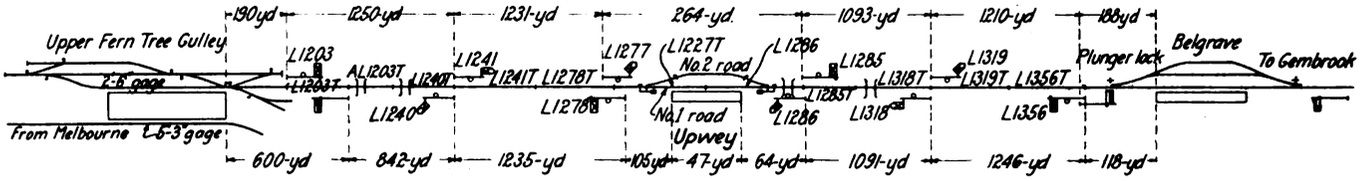


Fig. 2. Automatic Signal Location Plan

General Signaling Arrangements

The ruling grade between Upper Fern Tree Gully and Upwey is 1 in 30, rising to Upwey; between Upwey and Belgrave the gradient is 1 in 40 rising, except for a short distance when leaving Upwey where the gradient is 1 in 40 falling. Owing to the number of 3 chain (29 deg. 10 min.) and 5 chain curves (17 deg. 25 min.), the speed of the steam-operated trains over the line is never more than 15 miles an hour.

Upper Fern Tree Gully and Belgrave are "attended" crossing or passing track stations, and Upwey is an "unattended" station. When a train arrives at Upwey, the guard (conductor), unless otherwise arranged, is in charge of the station until the departure of his train; when two trains are at the station the guard of the train arriving first is in charge. The following terms have been adopted by the Victorian Government Railways for differentiation of types of block sections used in single line automatic signaling. "Single Line" section is the entire section of track extending between two passing stations; "Track" section is any division of a "Single Line" section the entrance to which is governed by a fixed signal.

The departure or starting signals at Upper Fern Tree Gully and Belgrave are controlled by an operating switch, and the control for these signals is arranged so as to give adequate protection for opposing movements. A track indicator, with "Track Clear" and "Track Occupied" discs, is provided at each of these two stations to indicate when the signal will respond to the movement of the control switch. Should one or more trains be required to follow in succession before a train is due to arrive from the opposite end of the single line section, the control switch is left in the reverse position, and the departure signal will work automatically as the track sections are cleared. During the time the control switch is in the reverse position the opposing departure signal at the opposite end of the single line section is locked in the "Stop" position.

The arrival or home signals at Upper Fern Tree Gully and Belgrave are mechanically operated lower-quadrant signals. The signal arm at the former station is provided with a Reid's d. c. reverser, and the control to the reverser is taken through a circuit controller attached to the signal lever, operative when the lever is reversed, and through the track circuit between the arrival signal and the opposing departure signal. As the track circuits terminate at the down arrival signal at Belgrave, no reverser is provided for that signal arm. (This signal is shown in the background of the first picture at the head of the article.)

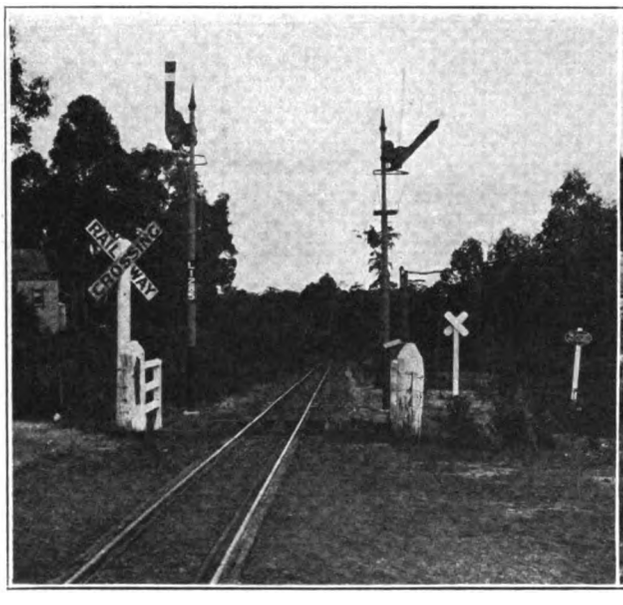


Fig. 3. Up Arrival and Down Departure Signal at Upwey

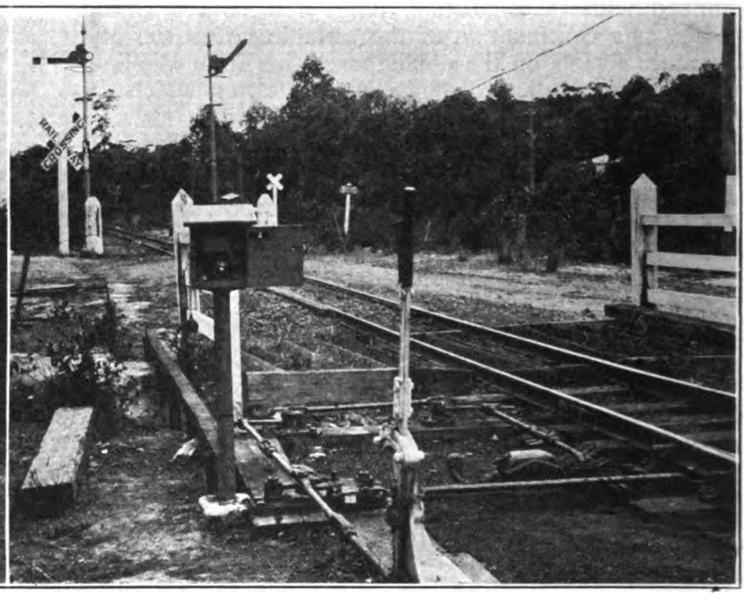


Fig. 4. Down End, Upwey Station Showing Signals, Release Switch and Switch Connection

Arrangements at Unattended Crossing Stations

The intermediate automatic signals work on the usual A. P. B. system, a full description of which was given

by C. A. Dunham, under "The Absolute Permissive Block System," in the *Railway Signal Engineer* for November, 1921.

When a train reaches a predetermined point approaching the arrival signal at an unattended passing track station, the departure signal controlling the entrance of that train into the *single line* section ahead, automatically rises from the "Stop" position to either the "Caution" or "Clear" position, provided that the switches are in the normal position; that the first *track* section ahead of the station is unoccupied; that there is no train approaching in the opposite direction on any *track* section of the *single line,* and that the opposing departure signal at the next crossing or terminal station is in the "Stop" position. Under these circumstances no manual operation is required at the station, and the departure signal operates in time for the "Clear" or 90 deg. position to be displayed at the arrival signal when the train reaches that signal.

When trains are approaching an unattended passing track station in opposite directions at the same time, the automatic signal in the rear of the arrival signal will show "Caution," due to the train travelling in the opposite direction being in the *single line* section ahead; and when the trains which have to pass each other are closely approaching an unattended station, the arrival signal in both directions will be automatically placed at the "Stop" position. The usual arrangements are that the train due to arrive first is booked into No. 2 road (passing track), see Fig. 2, and, although the arrival signal may be displaying a "Proceed" indication, the train must be brought to a stand, the guard or fireman goes forward and unlocks the padlock of the ground lever seen in the photograph and then sets the facing switches for the train to enter No. 2 road; and after seeing that the line into No. 2 road is clear and that no train is entering or leaving the opposite end of the station, the guard or fireman verbally instructs the driver to proceed, passing the signal in the "Stop" position. The arrival signals are provided with a pointed arm, and therefore the signals may be passed with the arm at "Stop" after a driver has come to a stand and received the necessary permission.

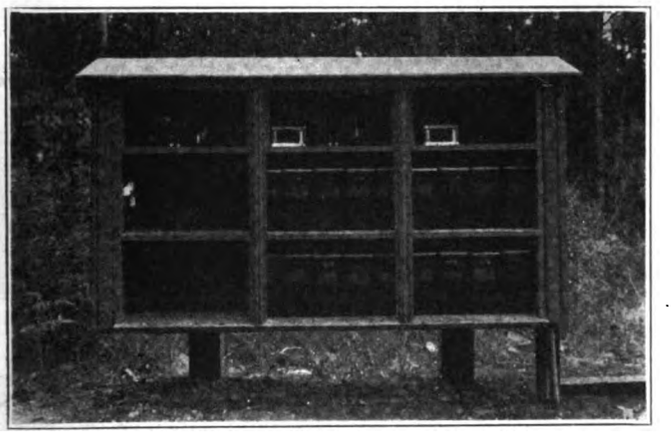


Fig. 5. Primary Batteries and Relays Are Located in Wood Boxes Above Ground

The passing track is non-track circuited between the fouling points, and the control for the arrival signals is taken through the platform track circuit for the through route only, the control being also taken through a switch circuit controller connected to the switches at each end of the station, the reversal of the switches therefore puts the signals to "Stop."

Immediately the train has passed clear of the facing switches, the guard restores and locks the switches in their normal position set for No. 1 road (main line), and when the train has stopped clear in the passing track the arrival signal for the train approaching in the opposite direction will go to "Caution," and later to "Clear" when the departure signal for the *single line* section ahead goes to "Caution" or "Clear," provided that the *track* section ahead or the *single line* section in advance is unoccupied respectively; the signals thus work automatically as if no train was standing in the passing track, and the train is able to proceed without further signaling operation.

When a train is due to leave from the passing track, the guard goes to the releasing switch box, (seen in Fig. 5, there being two such boxes which are locked and one situated at each exit from the station), opens the cover of the box. Before depressing the plunger for the purpose of clearing the departure signal it is his duty to observe the position of the arrival signal located beside the departure signal which he desires to operate. If a "Caution" indication be displayed at the arrival signal, it denotes that no other train travelling in the same direction is closely approaching, otherwise the signal would be at "Stop." If the signal be in the "Stop" position, thus indicating that there is a train in the section in the rear, the men in charge of the train at the unattended station should be aware whether such train is travelling away, or approaching them, and if it be another train approaching them they must not attempt to foul the exit from the passing track until the approaching train has arrived and stopped. If, however, the arrival signal is displaying a "Caution" indication, or when the following train (if one be approaching) has been stopped, the guard of the train to be dispatched from the passing track may then press the plunger firmly in, and he holds it there for a couple of seconds, when the departure signal arm will go to "Caution" or "Clear," according to whether the track section ahead or the single line section to the next crossing or terminal station be clear; and by this operation the opposing departure signal at the opposite end of the single line section is locked in the "Stop" position, and the intermediate signals for trains in the opposing direction are put to "Stop." On the operation of the departure signal the guard reverses the switch lever and sets the trailing switches for the train to leave the passing track, and the arrival signal arm goes to "Stop" as seen in Fig. 5. When the front of the train has passed the departure signal, the releasing switch box is closed and locked, and after the whole of the train has passed over the switches, the guard restores and locks the switch lever in the normal position with the switches set in position for the main line and the train can then proceed on its way.

The circuit arrangements for obtaining the above operation are shown in the sketch. The special relays (ZR),

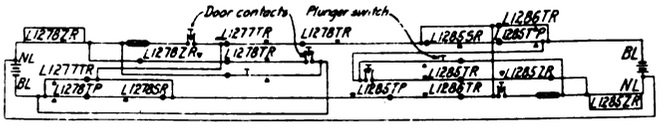


Fig. 6. Circuits for Manual and Automatic Control of Departure Signals at Unattended Passing Sidings Stations

which are 1000-ohm two-position line relays, are taken into the control of the signal mechanism circuits, the relays being energized through the combination set up according to the conditions of the route required. The box containing the releasing switch is provided with door contacts arranged to isolate the manual clearing circuit from the automatic clearing circuit when the door is opened.

The electric locking of opposing departure signals for

the single line sections is done by means of a circuit taken through a contact on the circuit controller in the signal mechanism of each departure signal. This contact is closed when the signal arm is in the "Stop" position, but immediately one arm rises from the horizontal position the circuit to the opposing signal mechanism is opened, and will remain open until the *single line* section is again unoccupied.

The three-position, upper-quadrant, 10-volt d. c. signal mechanisms, the releasing switch boxes and the 670-ohm polarized signal control relays were supplied by the General Railway Signal Company. The 4-ohm two-position neutral relays used for track circuits and the 1000-ohm two-position line relays, were manufactured in the signal department shops at Newport.

Waterbury primary cells of 500 a. h. capacity in rectangular glass jars, are used for signal and track circuit operation. Two cells in parallel are used for each track circuit, with an adjustable track resistance in series. The batteries and track resistances for two track circuits are housed in one wooden box. The relays and 18 cells, required for the operation of two intermediate automatic signals, are housed in a large wooden box.

As the circuit drafting is done on the written circuit principle, all wires are numbered, and the number is stamped on fibre labels. This practice has been carried out from the commencement of the installation of power and automatic signals in the suburban area, and has been found to be of valuable assistance both on construction and maintenance work. In general the wiring nomenclature and the symbols follow the standards of the Signal section of the A. R. A., but in some cases modifications have been made to suit local requirements.

The rails are bonded by two galvanized iron wires, No. 8 (S. W. G.), wedged into the rails with channel pins, and clips are fitted to the fishplates for holding the bonds in position. Long-burning oil lamps are used for the signal and marker lighting.

Aristos copperweld wire, No. 10 B. & S., 30 per cent conductivity, double braided and weatherproofed, is used for the line wire between the different signal locations. Eight wires are required between the up and the down ends of Upwey station, and three wires for the remainder of the sections. The wires are run on the ordinary railway telegraph poles, an additional arm being provided for their accommodation. Connection from the poles to the relay boxes is made by means of Kerite insulated wire, which is run in wooden trunking, and connections from the relay boxes to the signal masts by means of R. C. T. B. wire, run in galvanized iron pipe.

The signal installation work was carried out by the signal department staff, under the engineer of signals, F. M. Calcutt, and was placed in service on December 22, 1921. Since that time the operation of the signals has been satisfactory and is likely to prove of valuable assistance in obtaining authority for future installations elsewhere on the Victorian Railways.

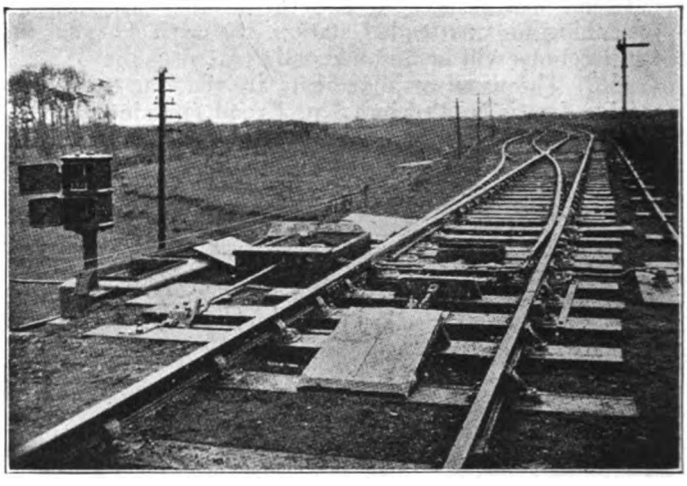
Twenty-eight cities report that, in the year 1921, the number of fatalities in automobile accidents within their limits was smaller than in 1920; and some of the differences are striking. In Detroit the number was 134 as compared with 240 in the earlier year; St. Louis 97 as compared with 192; Buffalo, 27 and 77; Indianapolis, 56 and 98; Milwaukee, 53 and 79; Newark, N. J., 44 and 70; Akron, Ohio, 13 and 26. These figures are given out by the National Automobile Chamber of Commerce, New York City, which finds that, for the nation as a whole, there was an increase in fatal accidents in 1921, though the total in proportion to the number of motor vehicles in use was less than in preceding years. For 1921 the number of cars registered was 10,448,632; number per thousand of population 99, and automobile deaths per 100,000 of population 11.

Long-Distance Operation of Facing Point Switches

OUTLYING switches of passing tracks and sidings on the railway operated by the Ashington Colliery Company of Northumberland, England, have been the first in that country to be operated electrically by primary battery and are controlled at a distance of 1,500 ft. from the signal tower. The following information is abstracted from an article in the Railway Gazette, London:

As the line is not open for public traffic, it is not subject to the requirements of the Ministry of Transport, but even if it were, the distance of 1,500 ft. would be accepted, as the limit for facing points worked by power is no longer fixed.

Next to the fact that the points are this distance away, the most interesting feature is that they are actuated electrically from primary batteries. In the pit on the extreme left is a 20-volt battery of 32 Edison caustic-soda cells and in the tower a 10-volt battery of 16 similar cells. In front of the pit is a relay case, in the upper part of which is a polarized switch control relay connected by an outward and return wire to a six-point control box on No. 7 lever in the signal box. In the lower part of the relay case is the track relay connected to a track circuit controlling the area between the fouling points on the two double lines up to the home signal immediately in the rear of the single-line switch points. This track relay controls the current to the polarized relay and the latter, in turn, controls the battery power for the switch mechanism.



Outlying Switch Operated Electrically

As in ordinary power frames, there are check locks on No. 7 lever, and its movement from normal to reverse must be made in two stages. The initial stage moves the circuit breaker in the control box so that current flows from the 10-volt battery, through the track relay to the polarized relay. If no train is in the neighborhood of the switch the latter relay operates and current passes into the machine seen between the battery pit and the rails, the switches are unlocked, moved over and relocked. In the center of the four-foot there is a box in which are electrical detectors for each switch point and the plunger. This is also coupled to the six-point control box on No. 7 lever and actuates the check lock. Thereby both switches of the points must be "home" and bolted before the check lock can be withdrawn to permit the stroke of the lever being completed. The same arrangement applies when the lever is being returnd to normal.

A derail is fixed in the down line—that on the right—near the starting signal. It is pipe connected to the switch. A switch box is attached to the derail also, through which the check lock circuits are run, and thereby it is guaranteed that the derail is fully on or off the rail, as the case may be.

About 3 amp. are required to start the actuation of the switch, but as soon as the initial movement of the derail is begun 2 amp. are sufficient. The time of operation is about 18 sec. The switch is moved about 80 times a day.

The work has been carried out by the Westinghouse Brake & Saxby Signal Company, Limited, 82 York Road, King's Cross, N. 1.