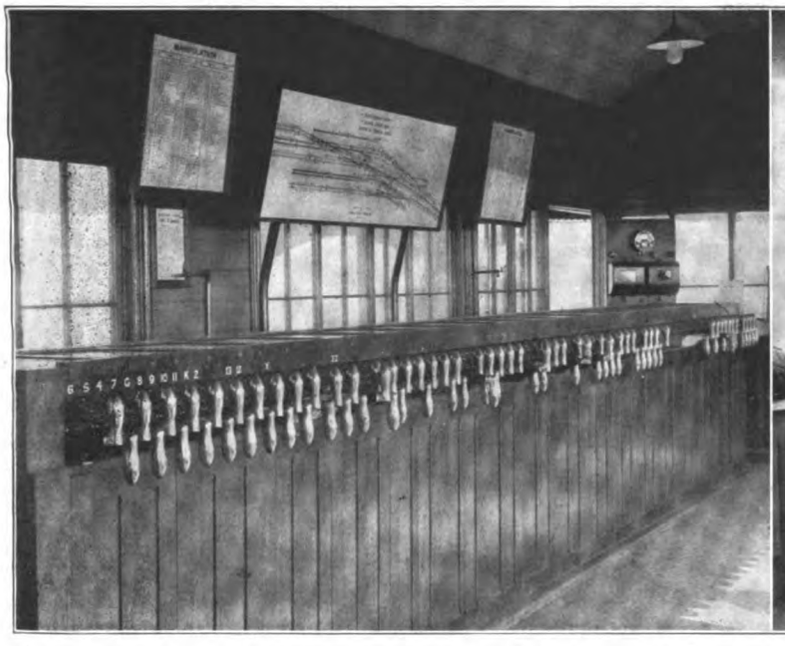
Electric Interlockings in Australia

Some Interesting Details of the First Installation in the Southern Hemisphere

By C. G. PILKINGTON,
Engineer for Signals and Yards, South Australian Railways

The recent enlargement of the passenger terminal of the South Australian Railways at Adelaide, South Australia, to accommodate a rapidly increasing suburban traffic in this important south coast city, involved an increase in the number of platforms from 6 to 13, extensive changes in the track layout, and the duplication of main lines from Adelaide Wye to the terminal station. These changes required a complete revision of the terminal yard interlocking, which consisted of 67 mechanical levers, and also of the South Line Junction plant, containing 42 levers. This latter plant and a 35-lever mechanical interlocking at Torrens Bridge Junction controlled the two legs of Adelaide Wye.

The cramped position of the yard cabin and lack of space for mechanical connections practically precluded the extension of the mechanical frame to handle the final layout, and electro-mechanical working offered practically no better solution. The matter finally resolved itself into a question of straight power interlocking, and after careful consideration of the various types, the G. R. S. dynamic, all-electric system was selected as being best adapted to conditions, and an apparatus of 100 levers and 36 spare spaces was installed.



Interior of Terminal Yard Cabin.

Interior of Junction Cabin.

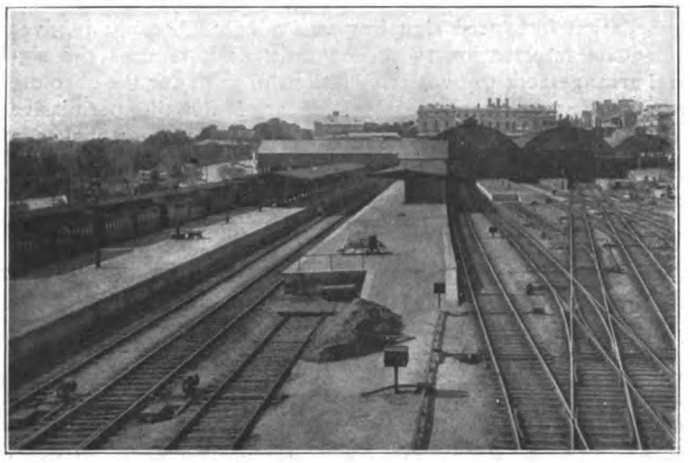
Since these changes would require the rebuilding of the South Line Junction plant, it was found that one power interlocking between the two junctions at the Wye, replacing both mechanical plants, would effect a substantial saving through the reduction in operating expenses, which capitalized, would more than pay for the cost of the installation of the power scheme. Accordingly it was decided to install a second machine of the same type at the Adelaide Wye, consisting of 43 levers and 13 spare spaces. The installations are unique in that the South Australian Government Railways pioneered south of the "Line" in using all-electric interlocking, speed signaling, the three-position upper quadrant signal with yellow light for caution, and permissive automatic signals.

Scheme No. 3 of the Railway Signal Association's recommendation for speed signaling was adopted because it gives adequate information to the enginemen; it reduces the signal arrangement to two combinations of arms for the absolute signals and two combinations of arms for the permissive signals, and finally, because of this simplicity, it makes a more economical installation. It should be understood here that the signal practice, as well as the railway methods as a whole, were up to this installation patterned after the British Board of Trade requirements. British signal practice, of course, is based on route signaling, and under the old arrangement at the station at least one of the up lines to the station had six arms or one for each platform. Therefore, to continue this scheme for the three approach mains either meant nine or ten arms for each signal location, or the use of three signals and route indicators below, giving the platform number.

Hence, after careful study and discussion between the traffic and engineering branches, the former declared themselvs willing to try the American scheme of upper quadrant speed signaling and the yellow light for "caution." As the old scheme required the use of red and green lights only, it will be apparent that this was a decided revolution for the traffic branch, and meant discarding everything except the red light and horizontal position of the arm for "stop" and the green light for "proceed." As the success of the installation depended on the trainmen having a thorough understanding of the signal aspects, a supplement to the rule book was worked up, showing the possible indications in colors, by day and night. The top or normal speed arm indicates the authorized speed for the vicinity; the medium speed arm indicates 15 miles per hour (it was the desire to make the medium speed 20 miles per hour, but it was necessary, unfortunately, to limit it to 15 miles per hour on account of the general use of 1 in 8 compounds) and the low-speed arm indicates ten miles per hour.

A signal diagram of the yard and Wye about 13 ft. long

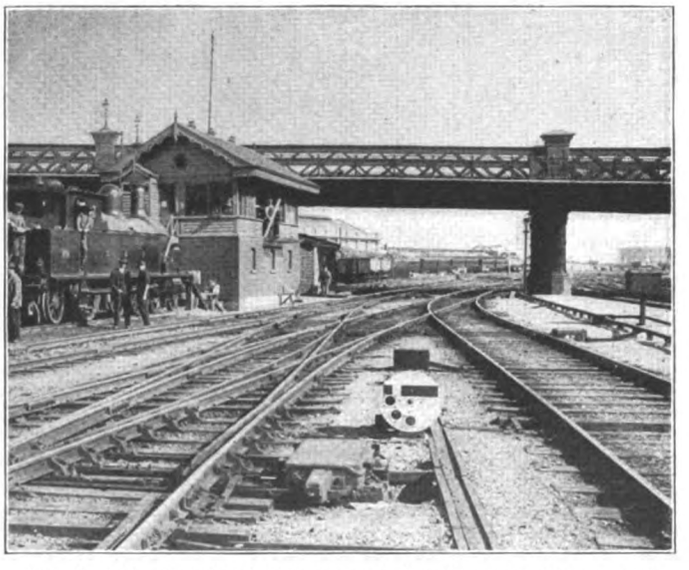
was made and fastened to a large table in a building adjacent to the yard cabin. Small working models of the various signals about 10 in. high were furnished, and the two head signalmen in the yard cabin took turns instructing classes of the enginemen and guards. The men, having been previously furnished with copies of the rule book, were required to arrange the signal indications for imaginary train moves through both plants. That this time was well spent was



Station Platforms and Tracks from Morphett Street Bridge.

proved after the plants went into service, for so far as is known, no delays or confusion resulted from the enginemen not being able to grasp the new indications promptly.

Although the absolute block had been consistently maintained prior to the new signaling, and the rules required trains to come to a full stop before passing a horizontal distant signal arm, the drivers soon saw the advantage of the permissive automatic signals which took the place of the starting and distant signals, and proper observance of these permissive signals has materially expedited traffic during the rush hours. It should be explained that absolute lock and

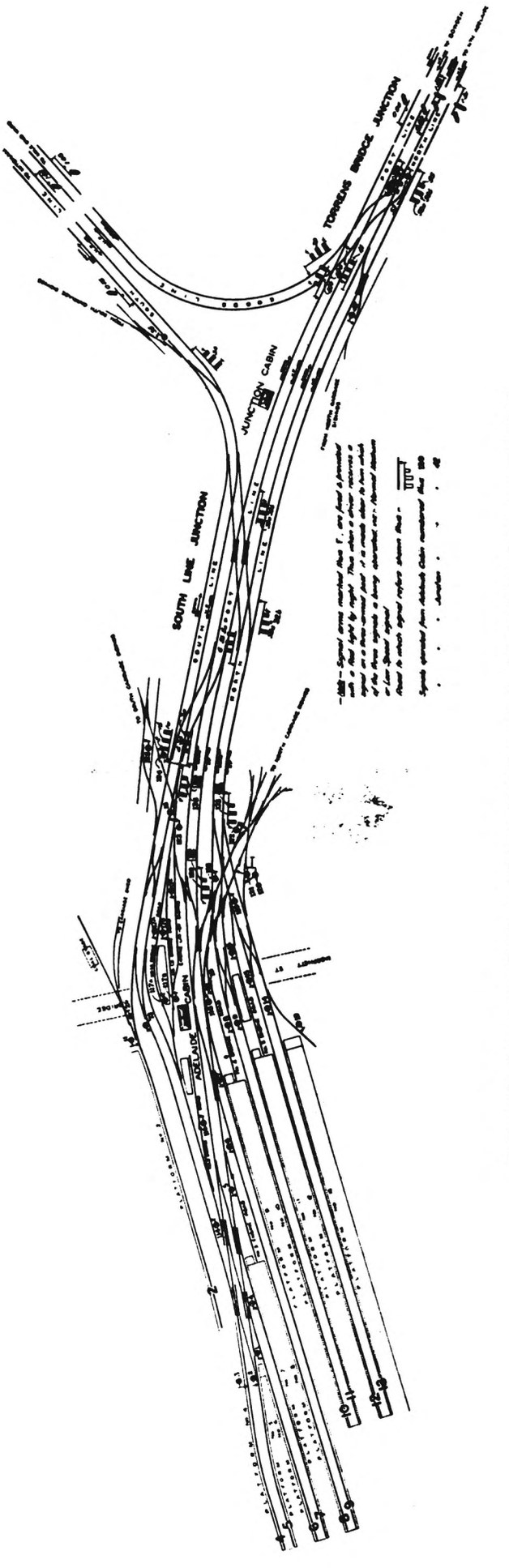


Terminal Yard Cabin With One of the Three-Position Dwarf Signals and a Switch Machine in the Foreground.

block is maintained between all cabins, but the installations between yard cabin, South Line Junction, Mile End, Torrens Bridge, Bowden and North Adelaide were removed and automatic signals with continuous track circuits without manual control were installed.

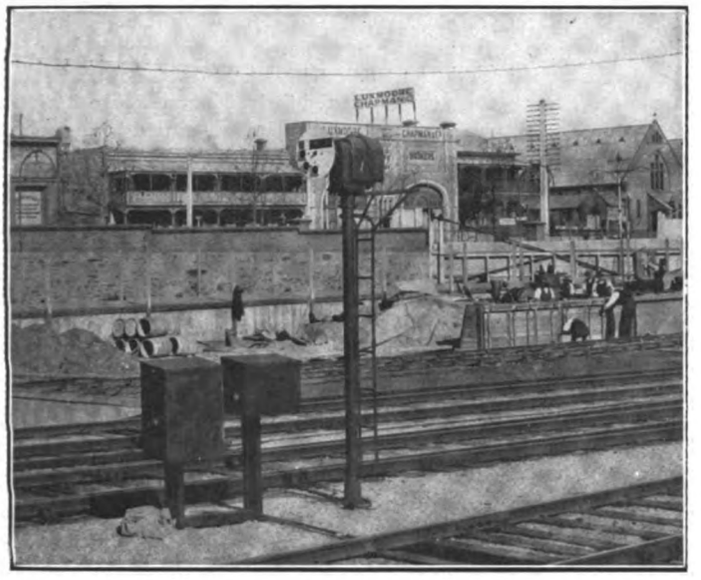
POWER EQUIPMENT.

The power for the plants is furnished from duplicate sets of 200-volt to 110-volt d. c. motor generators placed in the same power-house as the vacuum car-cleaning equipment at

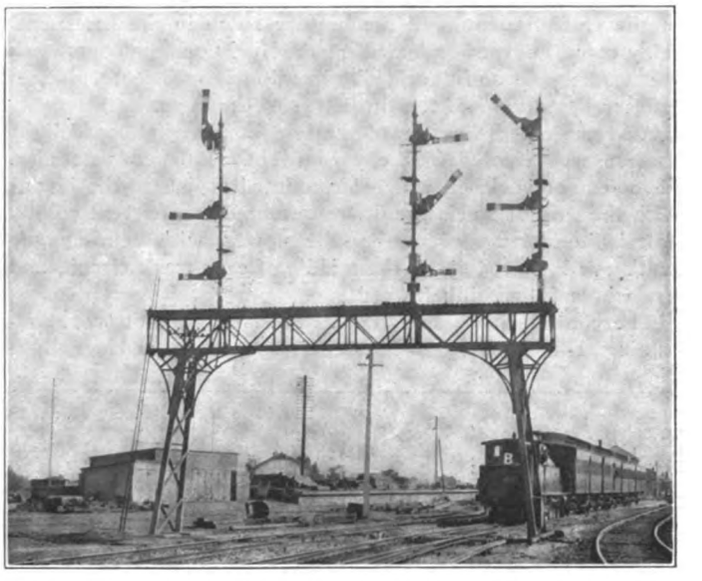


A Reproduction of the Track and Interlocking Layout at the Adelaide Passenger Terminal.

a point about midway between the yard and Wye cabins. These generators charge sets of 110-volt battery of 240-a. h. capacity, 14-volt battery of 960-a. h. capacity, and 4-volt battery of 750-a. h. capacity at the yard cabin, and 110-volt battery of 120-a. h. capacity, 14-volt battery of 240-a. h. capacity and 4-volt battery of 360-a. h. capacity at the Junction cabin.



Dwarf Starting Signal at End of Platform, Mounted on 8-Ft. Post.



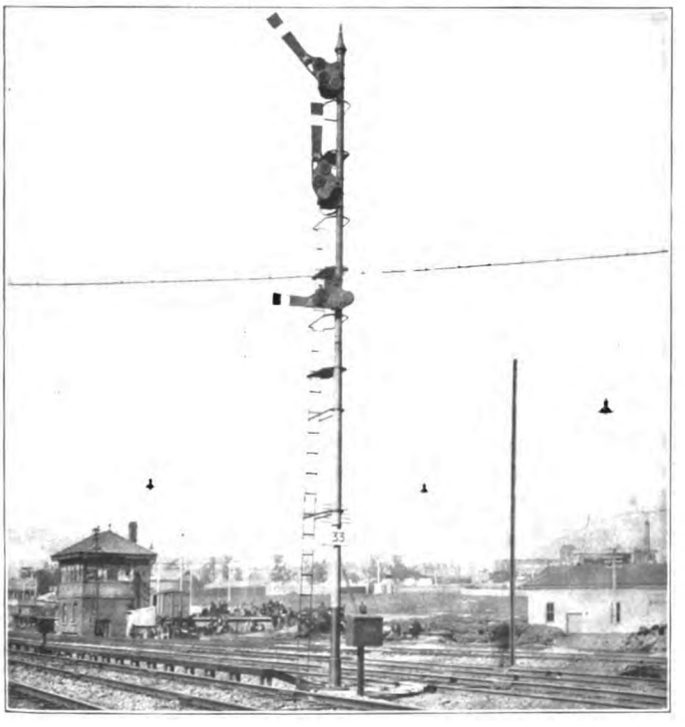
The Signal Bridge Spanning Two South Line and One Port Line Tracks.

The 110-volt batteries have capacity sufficient to run the interlocking machines for about 10 days, but the 14-volt batteries, supplying current for lever lights, repeater and line relays and an illuminated diagram at the yard cabin, require charging every 4 or 5 days. It was desired to use alternating current for the lever lights and diagram, but none is available in the vicinity. The 4-volt batteries supply the track circuits through a bus line. It is a matter of interest to know that the total energy required for the operation of switches and signals at the two plants probably would not be equal to half a dozen 16-c. p. lamps burning continuously.

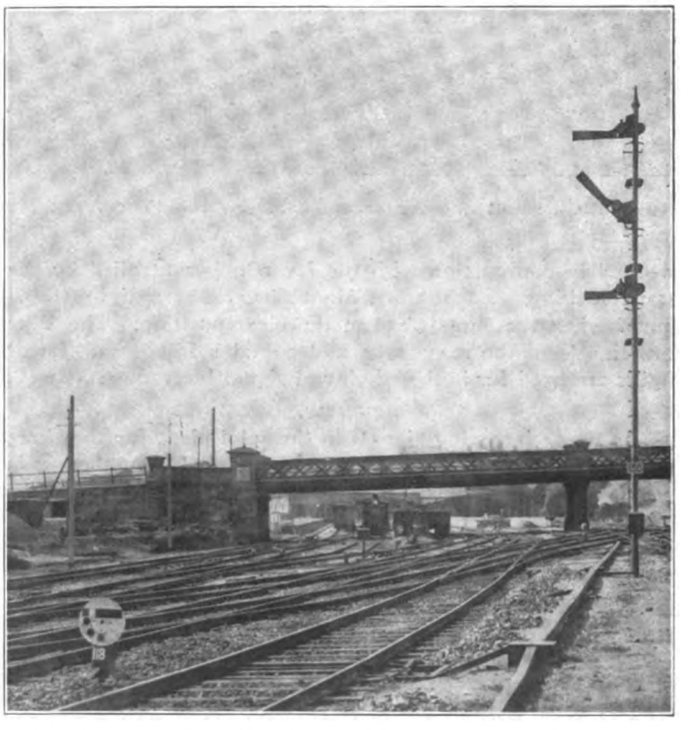
CABINS.

The yard cabin offered difficulties in the matter of installing the machine, as it was stipulated that the existing mechanical cabin, being a substantial building and in a most suitable position, should remain to house the power machine. This meant the erection of steel I-beam columns in concrete piers capped with I-beam girders, one end of which was set in the rear brick wall of the cabin.

The fact that the depth of the power machine is less than 3 ft. enabled it to be erected on the same floor and parallel with the mechanical machine. This made it easy for the signalmen to pass from the old to the new when the plant went into service. After the mechanical machine was torn out, a new floor was laid, windows placed in the back of the cabin, and a bay window installed in the front.



Inbound Port Line Signal No. 33, With Old Junction Tower in Background.



Three-Arm Inbound Signal on the Port Line, Showing Top Blade Fixed.

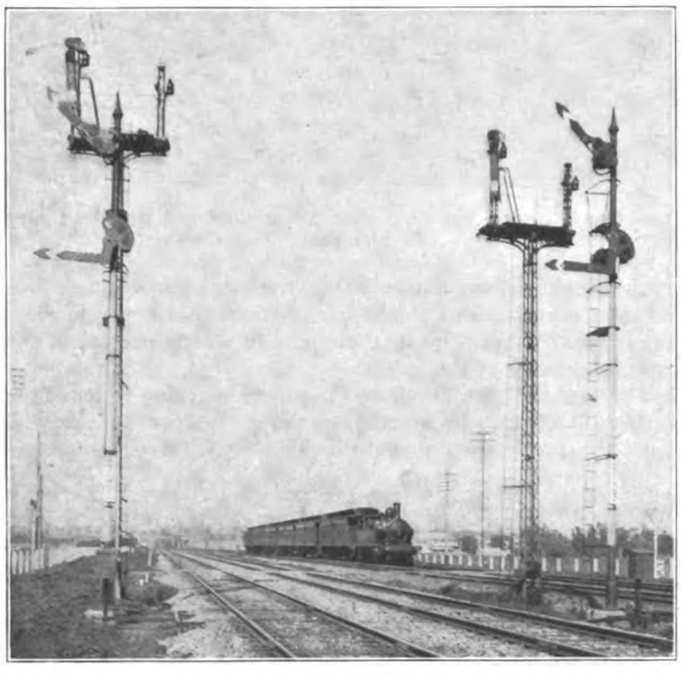
The ground floor of the cabin contains an angle-iron re-

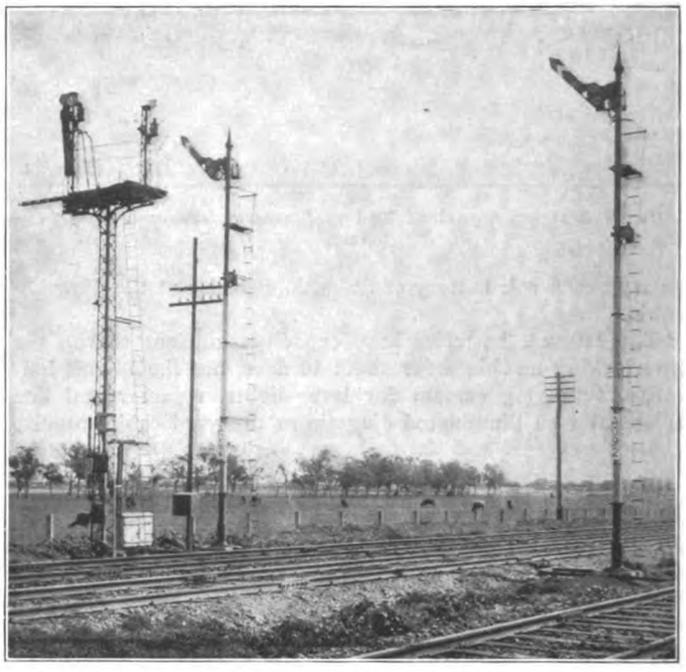
lay rack, with wooden shelves, the whole enclosed in glass. This rack was placed under the machine to shorten and make easy the inside wiring. The power switchboard is placed at one end of this room, and the storage battery in a brick battery house adjacent to the cabin.

The Wye cabin is a new brick building, built on the edge of the embankment with the battery room in the basement, relay room and power board on the first floor and operating room on the second floor. The location is such as to give an uninterrupted view of the three legs of the Wye.

An illuminated diagram of the telephone switchboard light pattern was erected in the yard cabin. This consists of a fibro-cement back, on which is mounted a plan of the layout with the various track circuits represented by different colors. A telephone lamp of one candle power, with semi-opague bull's eye is placed about the middle of each track circuit, and the whole is suitably framed.

The yard machine is of the G. R. S. multiple unit type, containing 186 spaces. Each switch lever has a lever light





Automatic Distant and Advance Signals on the Four-Track Main Line Beyond Torrens Bridge Junction, Showing Old Mechanical Signals.

worked in conjunction with the lever lock controlled by the track locking. Each home signal lever has a light which burns when the signals are in the clear position. The Wye machine is of the same type and contains 56 spaces. Lever lights are used for both switch and signal levers here as well.

SIGNALS.

The up or incoming signals in the yard plant for the three mains—North, Port and South—are Model 2-A three-arm poles, one of which is placed on the signal bridge with the Wye signals. As the station is dead-end, the top arms are made fixed, and the medium speed arms, which are semi-automatic stick, work from 0 deg. to 45 deg. only. The "calling on" or lower arms work in two positions also and are controlled by two levers. One of these levers controls movements into the platforms when occupied, and the other lever is used for a movement into the coal stages. As the coal stages are much nearer to the signals and short sidings, the signalman can only let an engine into the coal stage by pulling the lever for that purpose.

The platform starting signals are three-position, Model 2-A dwarfs, 0 deg. to 45 deg. lever control, and 45 deg. to 90 deg. semi-automatic non-stick, the third position being controlled through the track circuits and the outbound home signals at the Wye plant. Where the starters came between platforms they were placed on small concrete foundations, but where they were located in line with the platform, they were put on top of an 8-ft. pipe post so as to be over the heads of people on the platforms.

The back-up dwarfs and carriage siding starters are of the two-position, Model 3, solenoid type and where these signals generally govern backing trains from the carriage sheds, they also were placed on high posts to improve their sighting. The sighting of all the dwarf signals is extremely easy, as the dwarf spectacle is an enameled steel disc about 22 in. in diameter with the arm indicated in red on a white background. These dwarfs are a great improvement over the small-arm type.

At the Wye, the three-arm signal arrangement was carried out for all interlocked signals—the normal, medium or calling-on arms being fixed in each case, where they were not required. The approach or distant signals and automatic advance signals being normally clear and fed from a pair of 110-volt feeders run out on the telegraph pole line from the Wye cabin, were equipped with hold-clear attachment similar to that used on Model 2-A low voltage and a. c. induction motor signals in order to keep down the energy consumption.

SWITCH MACHINES.

The Model 4-A switch machines were used for all single switches and compounds as well as catch points and Hayes derails with the exception of the siding derails, some of which are catch points and others Hayes derails. These siding derails were operated mechanically from the detector bar connection on the switch machine at the switch through the medium of switch and lock movements. The pipe was carried by guides on the ends of the ties. The standard fittings of the General Railway Signal Company were employed, the only change necessary being that occasioned by the 5 ft. 3 in. gage, which is standard in this state. As the switches are supported on cast-iron chairs, raising the rail about 2 in. off the tie plates, this permitted the No. 1 or switch tie plate to be laid without set, and still keep the cover of the machine below top of rail.

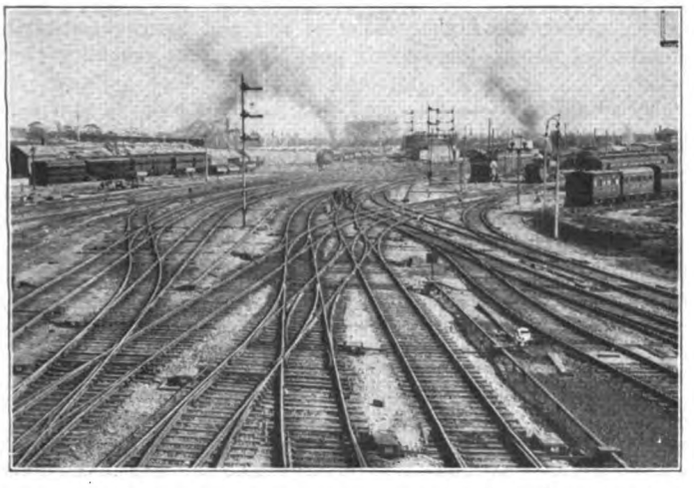
The rail section is 80 lb. and the ties of Jarrah. This timber is much harder than any with which American signalmen are familiar, requiring all holes for dog spikes as well as coach screws to be drilled. The Australian practice is to use round iron spreader rods, but the American arrangement of flat rods and point lugs was adopted so as to simplify the fitting of insulations and switch adjustments.

All facing point switch machines have embodied in them the switch circuit controller, which requires the points to be locked as well as in the correct position before the signal circuits are made. At mechanically operated catch points and for selection of third position controls in some instances, the Model 5 switch box was employed.

RELAYS.

G. R. S. relays were used throughout, with carbon to copper contacts for 110-volt signal circuits, and silver to carbon for all other circuits. Standard 4-ohm relays were used for the automatic signals and 11-ohm relays for the interlocking circuits. The line relays were 1,000 ohms, except where the control voltage was 110, in which case 2,000 ohms external was added.

The relay boxes were made of white pine with Cowrie pine bases, and mounted on posts made of old pieces of 60-lb. rail set in small concrete foundations. The sloping covers of the boxes were protected with galvanized iron, and inner or spring dust doors used. The trunking connections were



Looking Over the Terminal Yard from Morphett Street Bridge Toward the Junction.

carried up to the under side of the boxes by being fastened with clips to the base of rail. Where the relay ends of track circuits were convenient to the cabin, the relays were placed in the cabin.

TRACK CIRCUITS.

The track circuits are of the single-rail type; that is to say, no insulations were placed in the negative rail, as the negative rails were all bonded together, forming the negative return to the storage battery in the cabin. Both Weber and Continuous joints of the 4-bolt type were installed to enable a test to be made to determine what type of insulated joint to adopt for future work. The American oak in the Weber joints will be eventually replaced by Jarrah timber, as it is believed longer life will be secured thereby.

As previously noted, the track circuits in and adjacent to the cabin are fed from a 4-volt bus line through adjustable resistance units placed in the nearest junction boxes. The track circuits for the automatic signals are fed from two gravity cells in parallel. As it seldom gets down to freezing in this country, and then only at night, the gravity cells were placed in wooden cupboards mounted on two hardwood stakes.

CIRCUITS.

The control circuits are patterned very closely after the specifications of the R. S. A. All running signals are detected through switch boxes on facing switches and all catch points and Hayes derails are equipped with point detection for dwarf signals. Route locking for all high signals at the yard and Wye plants is secured by the use of normal indication locks on the signal levers, the route being held until the front of the train has reached the last track circuit in the route. No parallel or detector bars were employed for protecting switches, the detector track circuits with lever locks being used in lieu thereof.

The wire conforms to the British Cable Makers' Association specification for 2,500 meg-ohm grade with the exception of the Di-electric weatherproof line wire. No. 1/16 S. W. G. was used for controls and No. 7/18 for track connections. Nos. 7/18, 7/16 and 7/14 were used for common returns. All wires in relay boxes and common connections in junction boxes were placed on R. S. A. standard terminals, and all wires were tagged at all terminals and junction boxes by the use of fiber tags and stamped with steel stencils to conform to the wiring plan. Where wires were in trunking above ground, and in main cross runs, they were laid loose, but the track connections and small cross runs of trunking were pitched in, using a mixture of British pitch and tar to keep the mass pliable.

As the ravages of the white ant are legion in this country, Oregon pine, because of the ease with which it can be worked, was used after thoroughly soaking in Carbolineum Avenarious wood preservative, a dipping trough being built for this purpose. Pointed Jarrah stakes rough sawed, 3 in. by 4 in. by 3 ft., were used to support the trunking line; two stakes side by side were employed where the line exceeded 7 in.

The construction work was carried out by the contractors, R. W. Cameron & Co., with local labor under the direction of two skilled men brought out from America to direct the work. Considering that the maintainers required educating in the art of power signaling, in addition to the instruction of enginemen and signalmen, the plants have been working with a most satisfactory smoothness, and all the advantages anticipated, and more, have been realized.

OHM'S LAW AND THE D. C. TRACK CIRCUIT

BY H. D. W. R.

Some men engaged in the maintenance of signals are not familiar with the application of Ohm's law to the direct current track circuit, and it is the writer's desire to explain how a maintainer may use this law in his daily work and may draw for himself such curves as will assist him in testing his track circuits.

Ohm's law may be stated as follows: The current in amperes, flowing through a resistance is equal to the voltage across the resistance divided by the resistance in ohms, or

$$C = E/R \quad (1)$$

where C equals the current in amperes, E the voltage, and R the resistance in ohms.

The second law of Karapoteff is equally applicable to the direct current track circuit, and may assist somewhat in the derivation of the following equations, which show the voltage at the rails, battery end, and the series current flowing from the battery, both when there is leakage and when there is no leakage. The statement of this law is: The sum of the voltage drops over each resistance in a circuit is equivalent to the total voltage of supply, or

$$e + e' + e'' = E \quad (2).$$

Combining this with Ohm's law gives

$$cr + cr' + cr'' = E \quad (3).$$

If we consider first only that part of the circuit from the battery to the rail, where a fixed artificial resistance is inserted, we will have the equation

$$cr + e = E \quad (4).$$

This equation is in a form which when plotted always gives a straight line, assuming E and r to be constants and c and e variables. Therefore, for every definite value of c, there is a corresponding definite value for e. A graphical representation of these two quantities may be plotted, giving a straight line for every value of r and E used. After having plotted these two quantities, the maintainer will only find it necessary to read the voltage at the rails, refer to the curve for the particular resistance unit used, and read directly the series current flowing from the battery.

To plot the straight line representing any given values of