New Scheme of Interurban Automatic Signaling

Describing the Recent Installation on the Lines of the Washington, Baltimore & Annapolis Electric Railway

The Washington, Baltimore & Annapolis electric railroad connects the three cities named by a high grade, high-speed, 1200-volt D. C. trolley line having a double track road between Baltimore and Washington and a single track line from a point called Annapolis Junction, where it connects with the Baltimore & Ohio to Annapolis.

This single track line is 20 miles in length, and the eastern division, or that portion from Naval Academy Junction to Annapolis, a distance of 13.2 miles, was equipped with automatic block signals just preceding the Democratic convention of this year. A record for the quick installation of a complete system of automatic signaling protection was established, as the signals were in service 30 days after the first shipment of material and 49 days after the award of the contract.

The traffic over this road is passenger, local freight, and through freight. Trains of more than one car are used for passenger traffic as conditions demand. A shuttle, or city, service is also maintained between Annapolis and Camp Parole. On special occasions regular steam trains of the Baltimore & Ohio and the Pennsylvania convey over this signaled section a large number of passengers to Naval Academy exercises at Annapolis.

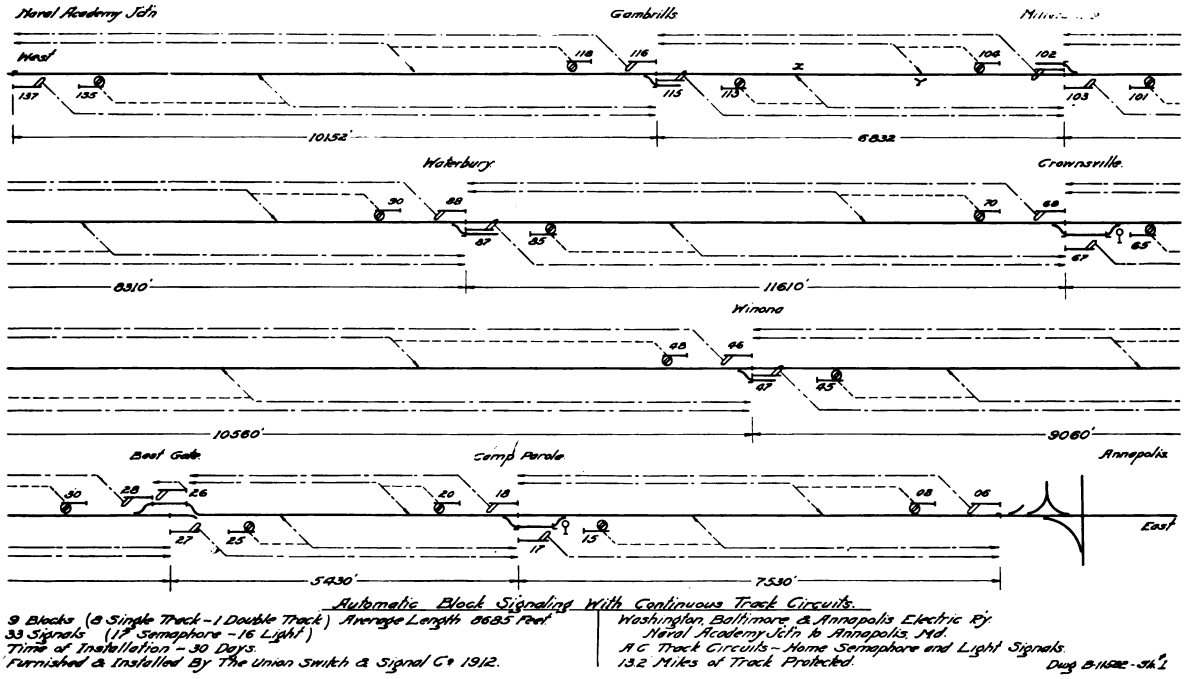


Fig. 1. The Layout of Tracks and Signals, Showing the Controlling Limits.

There are four stub and three double ended sidings on this line, one of which, "Best Gate," is a regular meeting point for scheduled cars. At this siding the switches are set for all cars to take the right hand track and trail through the exit switch. At other double ended sidings cars proceed at speed on the main line if they have no meets. Whenever possible these double ended sidings are used for meets with long freight trains.

The signal installation comprises 13.2 miles of protected track, eight standard single track blocks and one special block (Best Gate), 17 semaphore signals and 16 light signals. The longest block is 11,610 ft. and the shortest is 5,430 ft., an average of 8,680 ft.

The signaling is controlled by *continuous* track circuits which insure the signals remaining in the danger position so long as the block which they govern is occupied, and each car is fully protected in the rear as well as head on, i. e., but one car is allowed in a block at any one time.

All schemes for single track automatic signals prior to this installation employed a track circuit preliminary at one or both ends of the block in order to prevent two opposing cars from simultaneously entering a block under clear signals. This, under normal conditions operates perfectly, but with a deranged schedule on an interurban road, may cause either further delay to a car already late or require additional signals or indicators, at the entrance to the preliminary to minimize such delay.

An explanation of the function and disadvantage of preliminaries can be secured by reference to the Union Switch & Signal Company's Bulletin No. 57 or the 1911 report of the Block Signal Committee of the American Electric Railway Engineering Association. The elimination of preliminaries is unquestionably desirable if the substitute does not introduce unsafe or undesirable features. Therefore, with a view to overcoming the objection to preliminaries, the Union Switch & Signal Company designed an arrangement of signaling in which their elimination was accomplished. Instead of preliminaries, the arrangement employs two signals of the light type, and this scheme of signaling, with signals of the semaphore type located at the ends of the block, was adopted by the Washington, Baltimore & Annapolis, after a careful study of signal systems and arrangements by its general manager, J. J. Doyle, and engineer maintenance of way, E. W. Weinland.

This being the first installation of its kind, a detailed description will be of interest.

Each signal is numbered according to the miles, and nearest tenth, from Annapolis. Eastbound signal numbers end in an odd tenth because eastbound trains are odd numbered, whereas westbound signal numbers correspondingly end in an even tenth.

Fig. 2. Indicator and Switch Box.

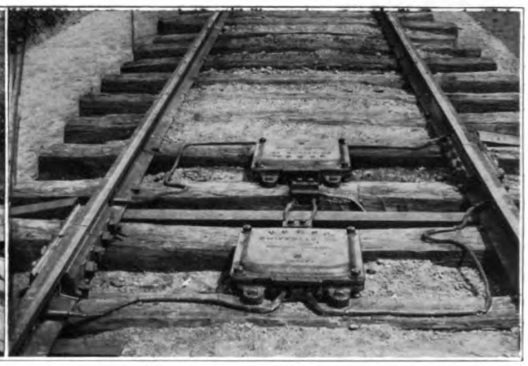


Fig. 3. Impedance Bonds.

The blocks extend from siding to siding and each has four signals, two of which are semaphores, located one at each end of the block, and the other two light signals, each about 1,000 ft. or more in advance of a semaphore signal. Referring to Fig. 1,

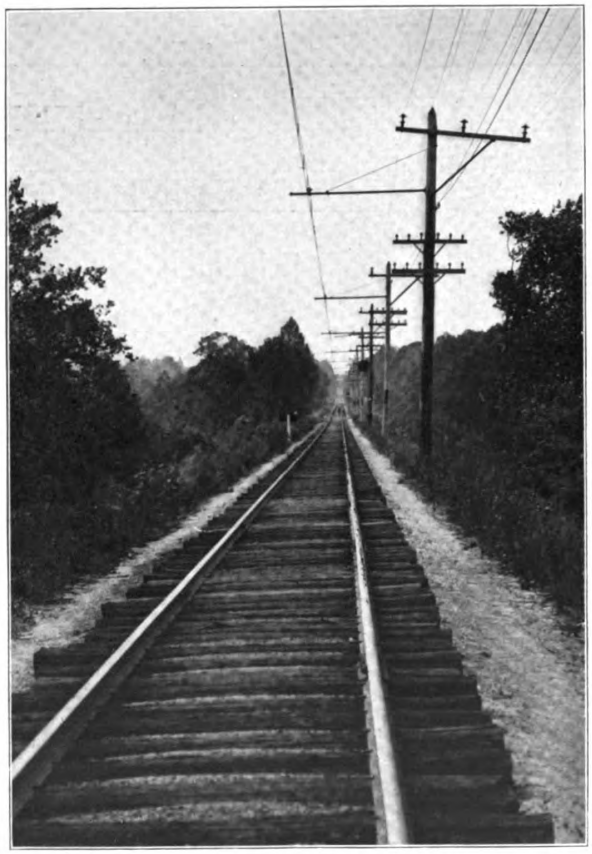


Fig. 4. Light Signals in the Pole Line.

the block between Gambrills and Millersville has semaphore signals 115 (for eastbound cars only) and 102 (for westbound cars only) with light signals 113 (eastbound) and 104 (westbound, respectively, in advance of the semaphores.

The minimum of track sections is employed in this system, one to each block, and its transformer, or source of energy, is in the center and operates two track relays. Referring to the above mentioned block from Gambrills to Millersville, one of the relays located at signal 115, is controlled by the track, to a point "Y," about 1,000 ft. or more *east* of the center of the block, and the other relay, located at signal 102, is controlled from this signal to a point "X," about 1,000 ft. *west* of the center.

Each semaphore signal is controlled by *both* track relays or the entire block. Each light signal is controlled by one track relay only, i. e., the one at the opposite end of the block and, therefore, by the two-thirds of the block at that end.

Considering the operation, an eastbound car entering the block under clear signal 115 places this signal, as well as 102 and 104 at Millersville to "stop." As it passes 113 at clear, and reaches "X," this signal is also placed to "stop." When the car is in the center of the block, between "X" and "Y," all *four* signals are held to "stop." These signals protect the car in the rear as well as head on. When signal 102 is passed all the signals for this block assume the clear position and it may again be entered at either end.

Cars standing on stub sidings back of the fouling, or clearance, point and between fouling points on double ended sidings, except at Best Gate siding, do not affect the signals.

A great advantage of this scheme is the facility with which car meets can be made, as opposing cars can proceed to a meeting point, such as Gambrills, without delaying each other or being subject to special rules as in systems having preliminaries. This is true because each block is a unit and a car in one block does not affect the movements of a car approaching an adjoining block.

The light signals act as a check should two approaching cars pass opposing semaphore signals at the same time; for example, should an eastbound car pass signal 115 at the same time that a westbound car passes signal 102, both would be stopped by signals 113 and 104, respectively, and one must back out of the block so that the other may proceed. This condition only arises when one car has overrun its orders.

Another advantage is the allowable close headway for following cars on account of preliminaries being eliminated and these eliminations secured without complication of operation or apparatus. Under a "preliminary" system, following cars in one direction are spaced the block distance plus the preliminary, which in such a case becomes an overlap, and as there may be passenger stops in the preliminary the delay to a following car may be extended. This scheme is also flexible as regards special conditions, two of which are shown in this signaling. One is the use of switch indicators to control movements out of sidings where the regular block signals cannot govern.

Switch indicators are miniature unlighted semaphore signals mounted on iron cases set on four-foot iron posts, and are generally employed to indicate when switches can be thrown to allow a movement from the siding to the main line. They do not apply to movements into the siding from the main line.

It will be evident that under this system switch indicators are

unnecessary at a siding, such as Gambrills, because a car, desiring to enter the main line, can be governed by the regular block signal 116.

The situation at Camp Parole, a double ended 1,000-ft. siding, required an arrangement whereby cars could safely and promptly enter the main line via the switch at the east end. As this siding is located on a curve and as a view of the block signal 17 would be impossible, at night in any event, a switch indicator was installed to provide the required indication. The situation at Crownsville is the same as Camp Parole.

Each indicator is controlled by the block in which the switch is located and a preliminary (track circuit) extending beyond the west end of the block. The "preliminary" control is installed, for example, at Camp Parole to prevent the switch being opened to let a car out of the siding, after an eastbound car has approached within 3,000 ft., more or less, of the block.

This, in reality, is a selective means whereby the regular car running on the main line, at speed possibly, receives and retains a right of way to enter the block against the car on the siding. If, however, the main line car were over 3,000 ft. from the block the siding car crew would receive the right to the block, throw the switch and block the main line car at signal 17. Without the track circuit preliminary control the siding car in all cases would have the preference and delay the main line car.

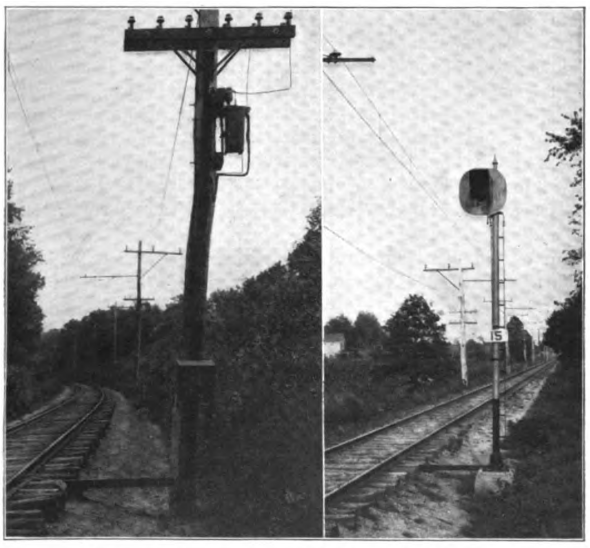
By the use of signal 15 no preliminary is required for this indicator at the east end of the block, for should a westbound car pass signal 106 as the switch is thrown, the car in the siding would be stopped by the westbound car having placed signal 15 to stop.

Attention is called to the fact that a car leaving this east Camp Parole switch has clear signal 15 in advance for its further information and assurance that the block is clear.

Cars on a siding may proceed promptly into the block when the block signal or switch indicator is clear. The action of each is wholly automatic and therefore requires no action on the part of the trainmen other than to stay or proceed according to the indication received.

Switches located at any point in the signaled territory may be equipped with switch indicators so as to protect traffic and only permit of movements to the main line when the block is clear.

The other special situation is the regular meeting point and



Figs. 5 and 6. Transformer Pole and Light Signal.

passenger stop at Best Gate siding. Here it will be noticed that signals 18 and 27 are controlled by the track sections between signals 18, 26 and 27, and signals 47 and 28 by the section between signals 47, 28 and 27, whereas the track section on the siding controls signal 26 only. If a westbound car reaches the siding first and passes signal 26, signal 27 will clear for an eastbound car. When the eastbound car passes signal 27 the westbound car may proceed promptly under clear signal 28. Should the eastbound car arrive first it will be held at signal 27 until

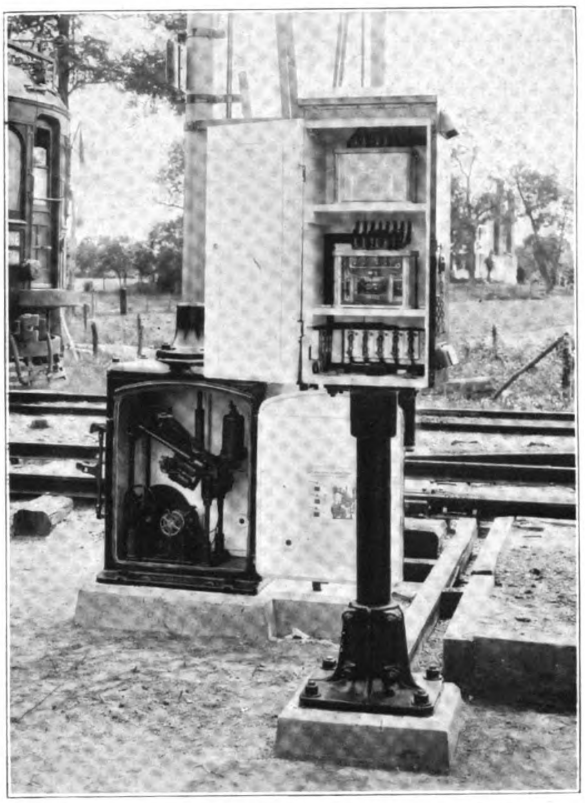


Fig. 7. Relays, Relay Box, and Semaphore Mechanism.

the westbound car passes signal 26. A passenger stop is located at signal 27 and the eastbound car discharges passengers *east* of the signal, if the westbound car is ready to proceed, but if the westbound car has not arrived the passengers are discharged *west* of the signal.

Fig. 8. Semaphore Signals—"Proceed" and "Stop."

Signal 26 was provided to allow a westbound car to pass signal 18 and still protect a car standing on the Best Gate siding.

The previously mentioned shuttle service between Annapolis and Camp Parole is protected by signals 06 and 17, as the car

does not proceed west of signal 17 and is, therefore, protected by the two signals mentioned. This signal displaced a hand-operated light signal arrangement between Camp Parole and Annapolis.

The signals at the sidings were located at the fouling point instead of at the switch point, in order better to protect movements into the sidings and also cause minimum delay to cars approaching the switch. For example: Movements in or out of the switch at Gambrills do not affect the signals of the Gambrills-Millersville block and also do not prevent a westbound car proceeding safely to signal 116, which will be at stop if the

Figs. 9 and 10. Block Signal Marker and a Light Signal.

switch is open or a car is fouling the main track. This switch will, of course, control signals 137 and 135 as well as 116.

If the signals were located at the switch point, an eastbound car taking the siding would necessarily hold signal 102 at stop, and if a westbound car had passed this signal there would be danger of having it hit the car at the siding.

Each switch, except the two at Best Gate siding which are trailed through, is equipped with circuit controllers so arranged as to hold to "stop" all signals governing the block in which the switch is located when the points are not correctly set for the main line. On this road cars head in and back out of siding except when this is prevented by special conditions.

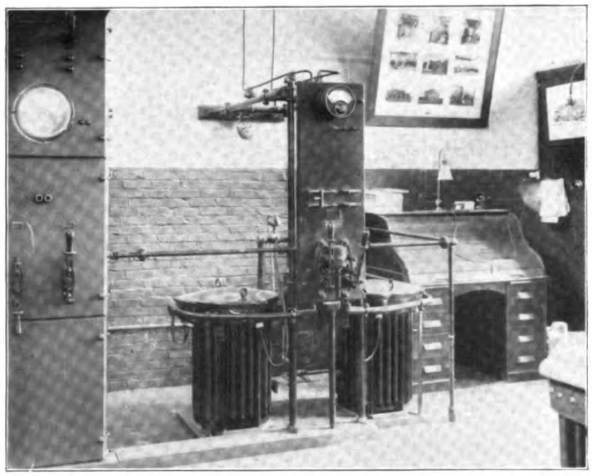


Fig. 11. Signal Switchboard and Transformers.

At present there are no distant signals; marker boards stating "Block Signal 1,000 ft.," are used instead.

No propulsion or other than the regular signaling current is employed for signaling purposes. The current for the signal system is distributed by means of separate mains, thereby making the signaling independent of interruptions and low voltage conditions, which would be incidental to its supply by the propulsion system. Power for this installation is taken from a sub-station located at Naval Academy Junction, where available 370-volt, 25-cycle current is transformed to 2,200 volts for distribution over the signaled territory. A separate General Electric Co. one-panel switchboard with ammeter and switches is included in the sub-station equipment. The line wire equipment consists of two 2,200-volt and three or four 110-volt line wires extending the length of the signaled territory. Transformers, high tension plug cutouts and high tension lightning arresters are mounted on additional short arms located on the regular trolley poles. Transformers located in the center of each block and tapped to the 2,200-volt line supply current through one secondary at about 10 volts for the track circuits, and through another secondary at 110 volts for the signal circuits.

The light signals are constructed of cast iron and provided with hoods and shields to improve the daylight indication by offsetting the effect of the sun. These signals have two five-inch lenses, one red and one green, and behind each are located two lamp bulbs wired in multiple. It is assumed that only one lamp will burn out at a time. No reflectors are employed.

Exhaustive tests showed conclusively that arc headlights have no effect on the distinctness of the indication of this light signal. These light signals give distinctive indications at about 1,600 ft. under the most unfavorable daylight conditions. The lamps employed in these signals are of the tungsten type, and the energy required for one entire signal is less than that required for one 16 c. p. carbon lamp. Each light signal is controlled directly by a 110-volt line relay which, in turn, is controlled by the galvanometer type track relays. The lamps behind the green lens are controlled by the front contact (closed with the relay energized) of the line relay and the red lens lamps are controlled by the back contact (closed with relay de-energized) of the same relay.

The semaphore signals are controlled directly by contacts on the track relays and also by contacts on the light signal line relay, without the use of extra line relays. The semaphores are electrically lighted and of the two position, horizontal to 60-deg., upper left-hand quadrant, well-known style "B," bottom-post mechanism type.

All track circuits are of the "double rail" type, which provides a two rail return for the propulsion current. Alternating current track circuits require better rail joint bonding than is generally maintained on electric roads, but as improved bonding saves propulsion current the net result is distinctively beneficial. It has been demonstrated that the current saved by the increased efficiency of the bonding will, in most cases, be several times greater than the current required for the signal system.

Rail joint bond testing becomes a simple and rapid matter where alternating current track circuits are installed, as a direct current ammeter across a joint produces a vibration of the needle if the bonding is poor, and vice versa, no effect if the joint is good.

Adjoining track circuits are separated by impedance bonds having a capacity of 500 amperes per rail and all insulated rail joints are of the "Keystone" type. The track circuits are carried into the sidings to the fouling or clearance points. All circuits are fused and provided with lightning arresters connected to a deep ground.

An existing ground wire, protecting the propulsion feed and high tension wires, is grounded to the rails by connection to the neutral of the impedance bonds located at each siding. The relays and low tension lightning arresters are located in wooden boxes mounted on the trolley poles or on separate iron posts.

Four months' operation under this signaling has fully demonstrated that it is well adapted to electric interurban conditions.

The material for this installation was furnished and installed by the Union Switch & Signal Company under the direction of J. J. Doyle, general manager, and E. W. Weinland, engineer maintenance of way, of the Washington, Baltimore & Annapolis Electric Railway.

The views of the signals and other apparatus will give the reader a good idea of the appearance, construction, and method of installation of this signaling.

Summarizing—This system is peculiarly adapted to interurban operation, as protection, speed, facility and simplicity of signal indications and rules are secured with a minimum and a simplicity of apparatus.