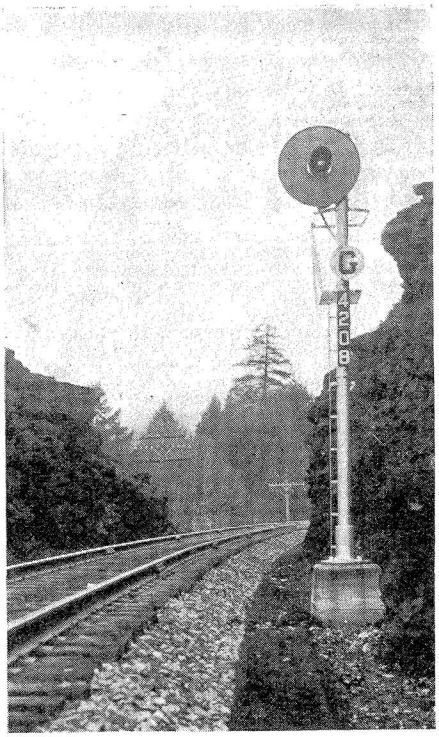


Typical intermediate automatic signal

Centralized Traffic Control Installed on the Virginian

Track capacity increased and over-all time reduced on 58.5 miles of single-track between Mullens, W. Va., and DB

As A means for increasing track capacity and thereby expediting train operation as well as improving safety, the Virginian has installed automatic block signaling and centralized traffic control on 58.5 miles of single track between Mullens, W. Va., and DB Tower, where connection is made with the New York Central System about 30 miles east of Charleston, W. Va. The Virginian also extends eastward from Mullens 376 miles to Norfolk, Va.

Large quantities of coal are mined within a fifty-mile radius of Mullens, and practically all the loaded cars are assembled and made up into trains in Elmore Yard which is just east of the station at Mullens. In earlier years, practically all of this coal was hauled eastward to Norfolk, Va., but in more recent years an increasing percentage is shipped west, a large proportion being handled by the Virginian between Elmore and Dickinson near Charleston, while the remainder of this westbound coal is delivered to the Norfolk & Western and the Chesapeake & Ohio through Gilbert, W. Va.

East from Elmore Yard, the line is double track for 20 miles through Matoaka, W. Va., from which point single track extends to Norfolk, with double track to the Virginian Coal Piers at Sewalls Point. The railroad is electrified between Mullens, W. Va., and Roanoke, Va., 134 miles, electric locomotives being used over the heavy grades in this territory. Steam locomotives are used east of Roanoke to Sewalls Point, as well as between Mullens and Dickinson.

Increased Traffic

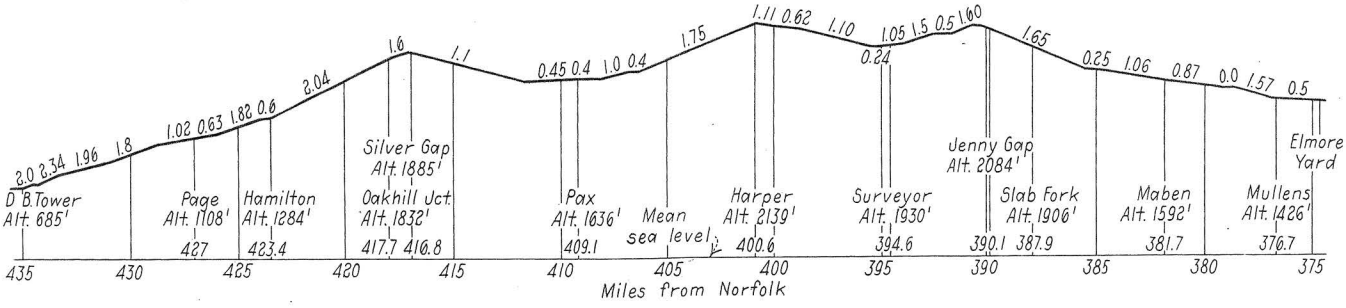
On account of the increased quantities of coal being mined and also on account of the increase in the percentage of the total tonnage to be moved westward under war conditions, the traffic on the 58.5 miles of single track between Mullens and Dickinson increased. Also, the through traffic other than coal, such as merchandise, has increased.

Grade Conditions and Train Speeds

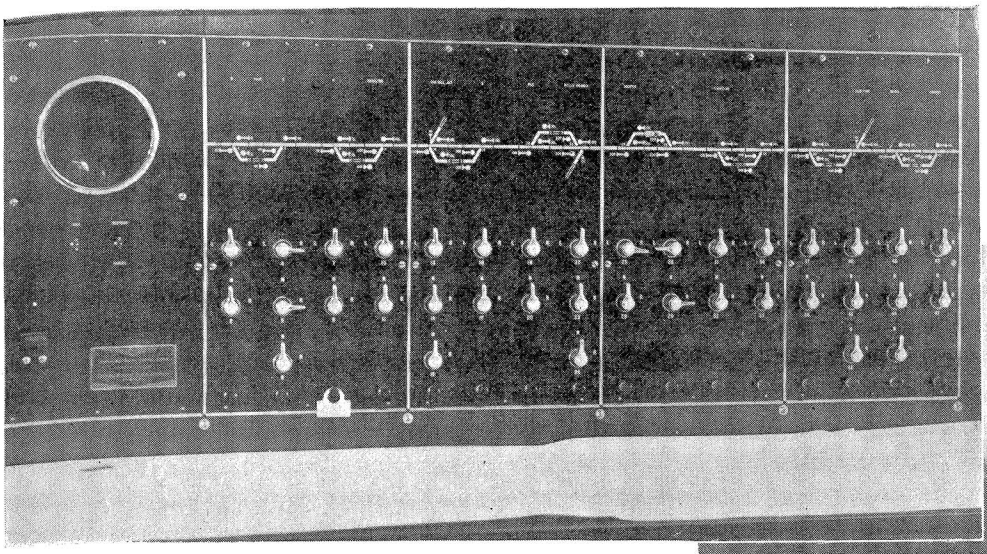
These various developments increased the number of trains to be handled on the single-track territory between Mullens and DB Tower, which is mountainous, the line passing over three ridges. With the exception of a few short sections, the entire line is on curves, the maximum being 12 deg. between Mullens and Page, and 16 deg. between Page and DB Tower. Helper locomotives are required on freight trains westbound between Mullens and Jenny Gap, and often as far as Silver Gap. Likewise, helpers are required for eastbound trains between DB Tower and Silver Gap, and in most instances on up to Jenny Gap. Three locomotives are required for each tonnage train of approximately 6,000 tons; the power includes 2-8-8-2 and 2-10-10-2 Mallett-type steam locomotives.

On account of the curves, the speed of passenger trains is limited to 30 m.p.h. between Mullens and Page, and to 20 m.p.h. between Page and DB Tower. The speed of freight trains is limited to 25 m.p.h. between Mullens and Page, and to 15 m.p.h. between Page and DB Tower. The average speeds are, of course, lower on the ascending grades.

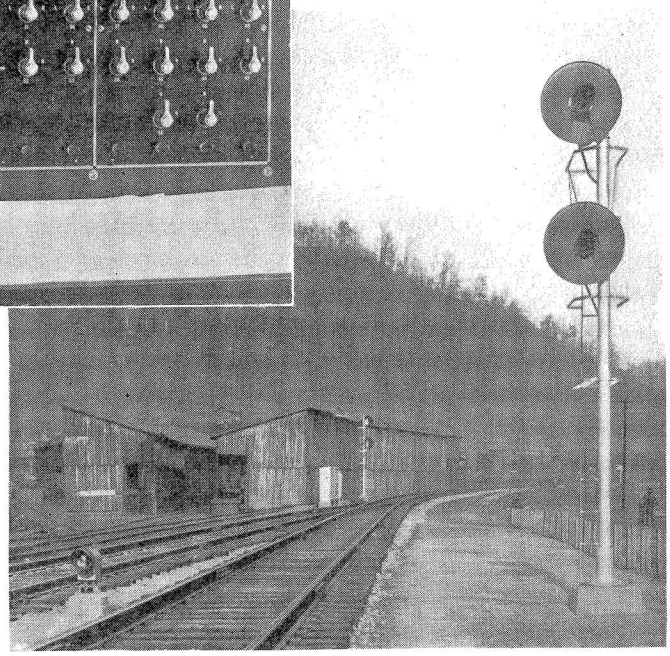
One passenger train is operated



Profile showing grades between DB Tower and Mullens



Left—The C.T.C. control machine at Mullens office has 16 levers to control 49 signals, 16 levers for 16 switches and 3 levers for electric switch locks



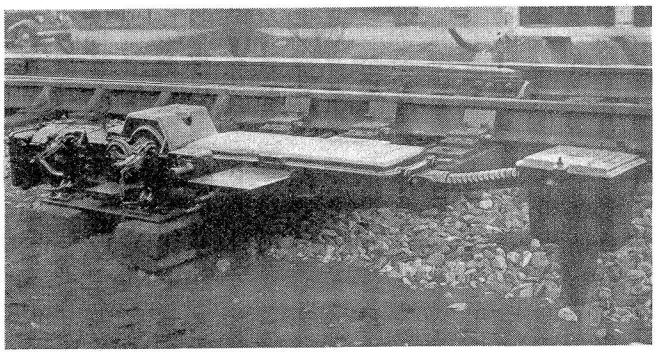
High signal and dwarf at leaving end of siding

each way daily. One scheduled time freight westbound and two time freights eastbound are operated daily. One local freight is operated eastbound one day and westbound the next day, excluding Sunday. The remainder of the traffic consists of trains of loaded or empty coal cars. Throughout this area the Virginian has numerous spurs and branch lines which serve coal mines. Coal which is to be moved east is hauled to Elmore for assembly into trains to be dispatched from this yard. Also, solid coal trains are made up at Elmore for movement westward to Dickinson, 16 miles west of DB Tower. The coal originating in the Mullens-DB Tower area for movement westward is picked up by westbound local freight trains or mine run trains. On each working day, one mine run train operates a round trip between Elmore and Slab Fork, another such train operates to Glen Roger, and a third to Surveyor. On the average, about four through coal trains are operated in each direction daily. The total number of movements, counting passenger trains, local freights, through freights, mine runs and helper moves, totals from 25 to 30 daily.

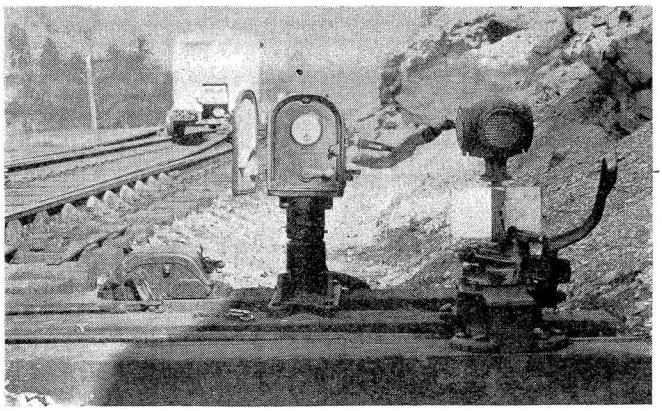
Passing Siding Layouts

On the new C.T.C. territory between Mullens and DB Tower there are 11 passing tracks, the car capacities of which are indicated on the track diagram shown herewith. Advance studies showed that the C.T.C. should serve to get the trains over this territory in less time, thereby reducing the number of occasions for using passing tracks. On this basis, no power-operated switches and semi-automatic signals were installed at three of the existing passing tracks, Lively, Cirtsville and Hotchkiss.

Two-"arm" and single-"arm" dwarf at end of a siding



Dual-control d-c. power switch machine



Electric lock on a hand-throw switch in C.T.C. limits at Slab Fork layout

These passing tracks are now used only for storing cars. When a train is to set out or pick up cars at one of these storage tracks, a part of the train is left on the main track, thus affording protection automatically. In the future, when adequate yard capacity is available at Elmore and other points, these three storage tracks may be removed entirely.

Power-operated switches and semi-automatic C.T.C. controlled signals are provided at each end of the eight remaining passing tracks, now referred to as controlled sidings, i.e., Maben, Slab Fork, Surveyor, Harper, Pax, Oak Hill Junction, Hamilton and Page. At the east end of Slab Fork, the east end of Pax, and the west end of Oak Hill Junction, branch lines are connected to the main track by hand-throw switches within the interlocking limits of the home signals so each of these switches is equipped with an electric lock controlled by the C.T.C. dispatches. At the fouling point on each of these turnouts and at certain other turnouts, there is a hand-operated derail which is equipped with a circuit controller connected to shunt the main-track circuit when the derail is off the rail. All hand-operated switches in the main line are also equipped with circuit controllers for shunting the main-track circuit when the switch is opened.

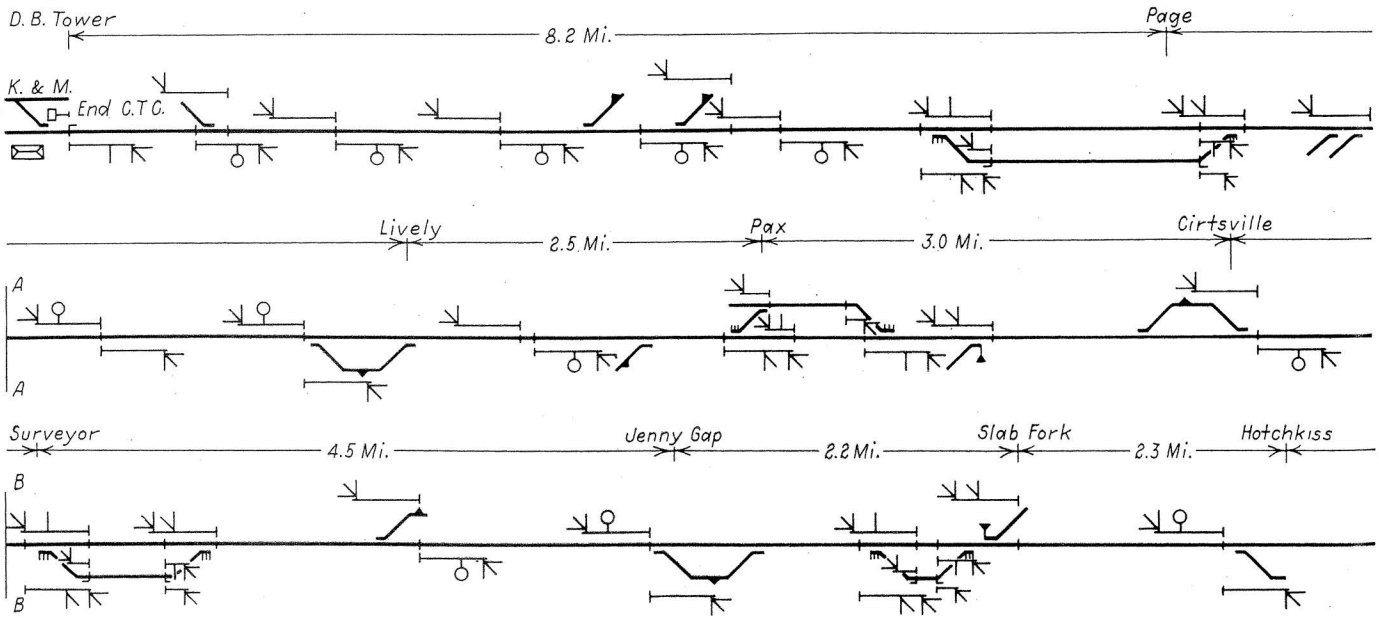
Searchlight Signals

The semi-automatic C.T.C. home signals at the ends of the controlled sidings are designated as such by the absence of number plates. Also, as a further distinction, these signals which apply to the main track each have two units. The station-entering signals and the main-line station-departure signals display green-over-red for Clear, yellow-over-red for Approach, and red-over-red for Stop. When a switch is reversed, the station-entering signal is controlled to display the red-over-yellow aspect, giving a train a diverging route to enter the siding at restricted speed.

All signals are located at the immediate right of the track governed. Where clearance was not available for a high signal between the main track and the siding, the main-line station-leaving signals are two-unit dwarfs, the lower unit displaying red in combination with red, yellow or green in the upper unit. The siding leaving signals are single-unit dwarfs, which display red for Stop, yellow for Approach when only the immediate automatic block is unoccupied, and green for Clear when two or more automatic blocks are unoccupied.

Intermediate Automatic Signals

A complete arrangement of intermediate automatic block signals is provided to protect and to space following trains as closely as practicable in order to increase track capacity. On account of the numerous curves and mountains, many of the intermediate signals had to be staggered locations in order to provide sighting distance. Automatic signals controlling trains on ascending grades are each equipped with a grade marker, which authorizes freight trains, when encountering a Stop-and-Proceed aspect, to proceed at restricted speed without stopping at the signals. Of the 52 automatic signals, 50 per cent are equipped with grade markers.

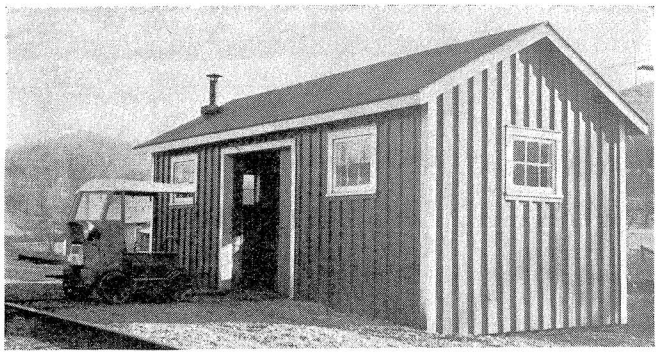


Track and signal plan of the C.T.C. territory

Power Switch Layouts

Each of the power-operated switches is equipped with a G.R.S. Model-5D dual-control low-voltage d-c. switch machine of the latest type with the out-board automatic magnetic brake. With 20 volts at the motor, a switch operates in about 9

seconds. Insulated gage plates and adjustable rail braces are used on three ties. On two ties the plates extend and are attached to the switch machine, thus preventing lost motion.

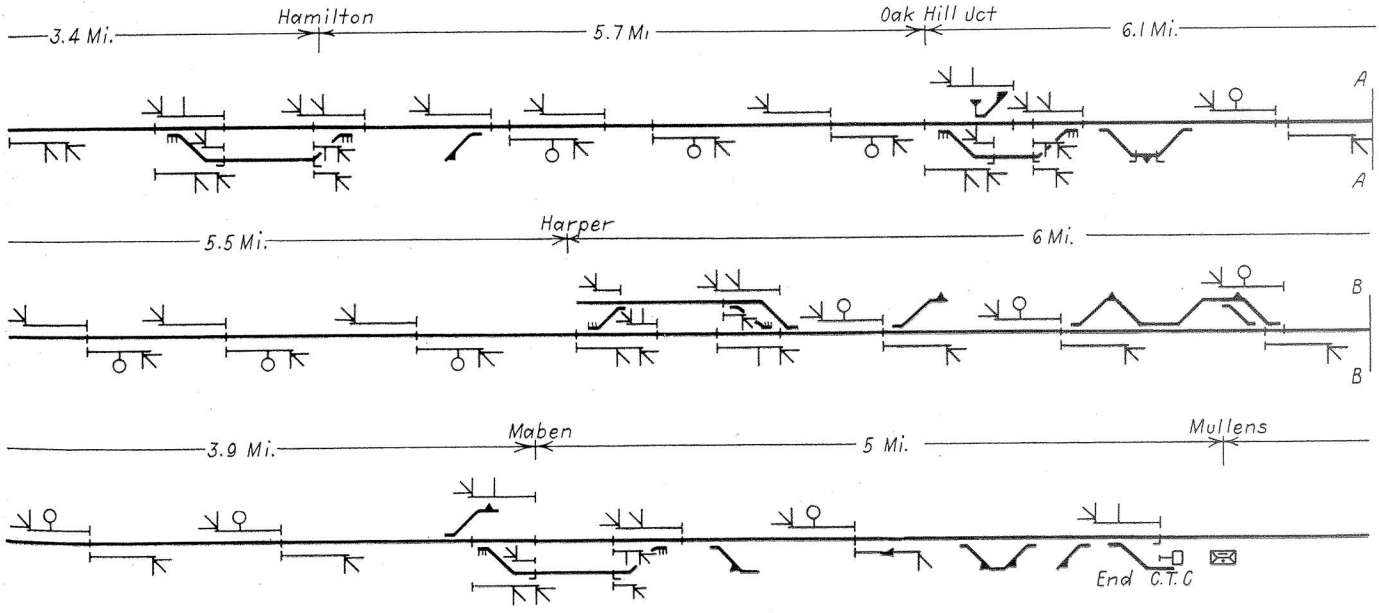


One new Fairmont motor car and a new tool house were provided for each maintainer's section

The C.T.C. Control Machine

The C.T.C. control machine, located in a separate 20-ft. by 20-ft. one-story brick building at Mullens, is handled by a dispatcher. The machine has 16 levers to control 49 semi-automatic signals, 16 levers to control 16 single switches, and 3 levers to control electric locks on hand-throw switches. The illuminated track diagram, above the levers, indicates track occupancy, all sections of the main track being included. When a train enters a passing track, the dispatcher places a token in a hole on the line in the diagram representing this track, and this serves as a reminder of the location of the train until it departs, at which time the token is removed.

The control of the power-operated switches and semi-automatic signals from the C.T.C. machine to the field stations, as well as the return of indications to the office, are accomplished by the General Railway Signal Company Type-H, Class-M line coded system using two line wires from the office at Mullens to the west switch and its associated signals at Page controlled siding. The code equipment has a capacity for 32 field stations.



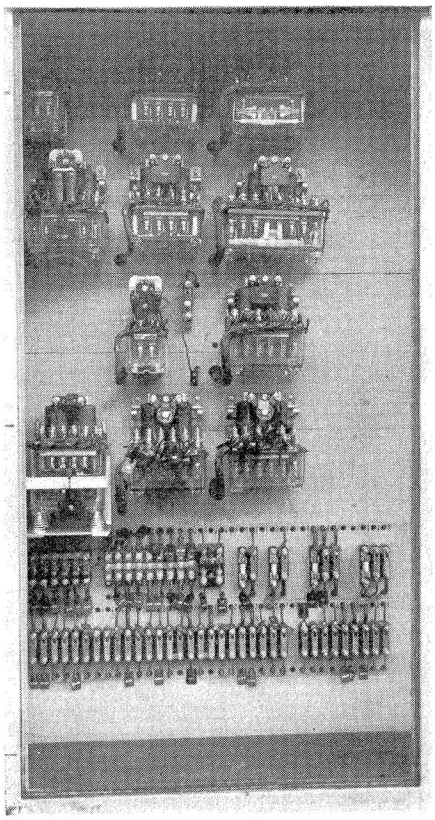
between DB Tower and Mullens

Benefits of the C.T.C.

The track capacity could not be increased by increasing train speeds because of the heavy grades and curvature, as well as the tonnage handled by trains. On account of the low average speed, the track-occupancy time of trains when moving between passing tracks is proportionally higher than would be under more favorable circumstances. Previously, the main line track-occupancy time for a train between two stations was further increased by the time lost when stopping to permit operation of hand-throw switch stands at passing tracks. Even for a well-timed meet, one of these heavy coal trains which had to enter and depart from a siding would lose 20 to 30 min. as compared with running through at normal speed on the main track. On account of the numerous variable factors in train operation on this territory, the trains often did not make the progress anticipated by the dispatchers, and, therefore, many of the meets were not at close timing, which further delayed the trains which took siding. Not only on account of the numerous trains and pusher locomotive movements, but also because of the accumulated overall time trains were required to make many meets.

The power switches, under the control of the dispatcher, permit trains to enter or leave passing tracks without being required to make the stops at switches. Thus the power-operated switches may save as much as 20 to 25 minutes for a tonnage train making a move out of one siding and into another siding for a second meet. This time saving in numerous instances permits trains to be advanced one or more sidings, when otherwise, with train orders and hand-throw switches, the train would have had to stay where it had been.

By means of the track-occupancy lamps on his diagram, the dispatcher knows the locations of and progress being made by each train. If a certain train is "falling down," he can advance opposing trains. For example, on November 12, an eastbound tonnage train with two locomotives had been making such excellent time that the engineman decided that he would be safe in passing up the usual stop for water at Pax, a special advantage being that he could get a run for the grade on up to Harper. In anticipation of this possibility, the dispatcher lined the signals for the move and put a



The instruments in sheet metal cases at switch layouts

westbound freight train in the siding for a meet at Harper. This operation saved approximately 45 min. for the eastbound time freight and did not cause the westbound to lose more than 20 min. In this instance, if the eastbound train had stopped at Pax for water, the dispatcher would soon know this from his diagram. This eastbound freight train made the run from Page to Mullens in 2 hr. 10 min., which is considered as a very good record as compared with previous operation under train orders.

Another Instance of Time Saved

On the same date, the dispatcher put a westbound time freight out of Mullens, expecting to put it in the siding at Maben for a meet with an eastbound train. However, the eastbound train had to stop at Lester to set out a car on which a wheel flange was broken. In the meantime, by means of the C.T.C., the dispatcher advanced the westbound train from Maben to Slab Fork, thus saving at least 40 min. for this train. Numerous other similar instances occur daily in which the C.T.C. serves to advance trains whereas, under previous methods of train operation, train orders could not have been changed in time to take advantage of rapidly changing circumstances. Over and above the time savings explained above, the intermediate automatic block signals permit following trains to be operated at the closest spacings consistent with safety. With this protection the enginemen have confidence to proceed at normal speeds, whereas previously, when making following moves, trains had to be operated at very slow speeds in order to be able to stop short of the train ahead, which might have stopped just around one of the sharp curves. Thus, with the automatic block signals and C.T.C., a tonnage freight can, in numerous instances, be advanced behind a passenger train or a time freight, whereas previously the tonnage freight would have been held back.

With C.T.C., the helper locomotives, when running light, can be moved back to the starting points promptly, thus saving a lot of time that previously was wasted when waiting on sidings at the crests of the grades. Now the helper crews can help three or more trains up a grade during an eight-hour trick, whereas previously there were but few instances in which more than two such moves were made in one trick.

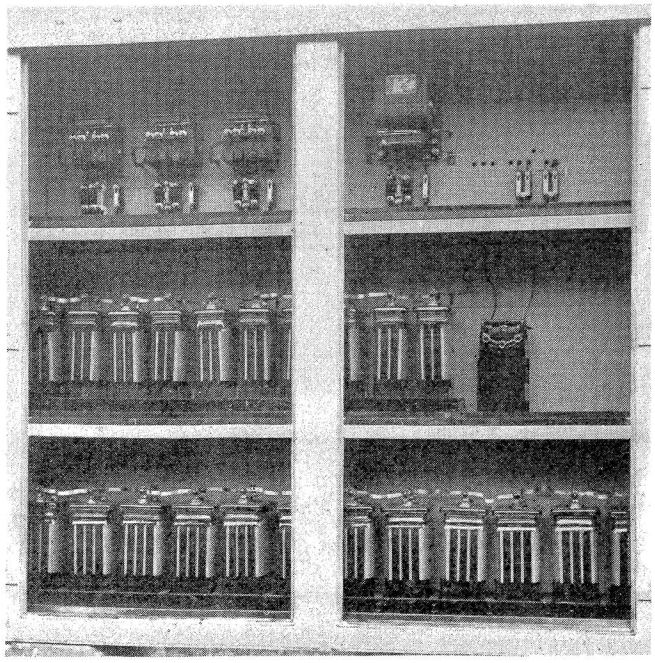
As explained by one of the operating officers, the C.T.C. system is an important aid in keeping the trains moving more efficiently and with greater safety in this territory which, on account of the traffic now being handled, would no doubt be congested if the signaling had not been installed. The enginemen and train crews appreciate the signaling facilities not only on account of the reduced number of train stops but also for the protection against collisions.

Before placing the C.T.C. system in service, the employees in train and engine service were required to attend instruction classes and to pass a satisfactory examination. Model signals, built to scale, were used in these classes, and emphasis was placed on the authorized and required speeds to be observed in accordance with the aspects displayed by signals.

Local Circuits in the Field

The rail joints are bonded with flash-weld Cadweld bonds applied at the side of the head of the rails. The track circuits are the conventional d-c. type using 4-ohm relays. The maximum track circuit length is 5,000 ft. In order to improve track circuit operation and shunting characteristics, a 2½-ohm variable resistance is placed in series with the relay, and a 1-ohm fixed resistance is used in series with the battery. The detector circuits at the power-operated switches are arranged to connect the main-line rails and the turnout rails in series. On these circuits, a 20-ohm variable resistance is used in series with the relay and 1-ohm fixed resistance at the battery end.

The automatic signal controls are based on the A.P.B. principle, using one line wire in connection with the common line wire for the controls of eastward signals, and one line wire in connection with common for the controls of westward signals. Selection between the Approach and the Clear aspects is effected by polar line relays. The operating coils of the searchlight signals are normally energized but the lamps are normally extinguished. In practically all instances, the track circuit in approach to each signal is long enough to enable the



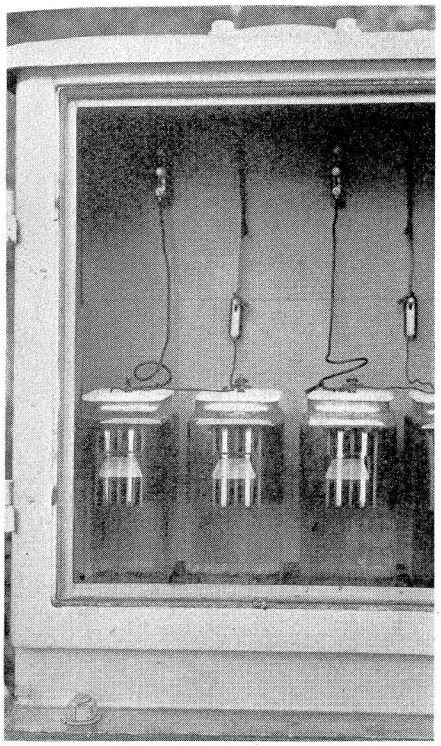
The rectifiers and batteries in a case at a power switch

control of the approach lighting to be accomplished through the back contacts of the track relay.

The approach locking circuits include one line wire in connection with common extending from each station-entering signal to the second intermediate signal in approach to the home signal.

Power Supply

Commercial power at 220-volts a-c. is available at 13 locations in this territory, and a two-wire power distribution circuit was extended short distances in each direction from each power feed location to include the power-operated switch layouts and automatic signal locations. A gap the length of one automatic block was left between the two ends of power feeds, thus saving about 30 miles of copper line wire.



Primary battery on the track circuit

At each power switch location, a set of 12 cells of Exide DMGO7 storage battery is provided for switch operation and for feeding the line coding equipment. At the intermediate automatic block signals, a set of five DMGO-5 storage cells feeds the signal operating coils and the line circuits, as well as serving as a stand-by for the signal lamps. In the C.T.C. control office at Mullens, a set of 20 cells of Exide BTM storage battery feeds the code line, and a set of 12 cells of EM7 battery is used to feed the code equipment as well as a stand-by for the indication lamps on the C.T.C. machine.

Interior of a case at an intermediate automatic signal showing relays

Where a-c. power is available for operating rectifiers, each track circuit is fed by one cell of Edison B4H storage battery. On circuits which are occupied by trains when stopped at water tanks or when switching, two such cells are used in parallel. At intermediate cut sections where no a-c. power is provided, each track circuit is fed by two cells of Edison 1,000-a.h. primary battery in multiple.

Instrument Housings

At many locations, the track is near to streams or mountain sides so that space is not available for locating large-sized instrument houses. For this reason, welded steel cases were used for housing the instruments and batteries. At each power-operated switch, the field location equipment is in welded steel cases, the C.T.C. equipment being in one case, the batteries in another and conventional type of relays in another case. At the intermediate signal locations and track cut locations, the relays and batteries are in welded steel cases placed on the line side of the track.

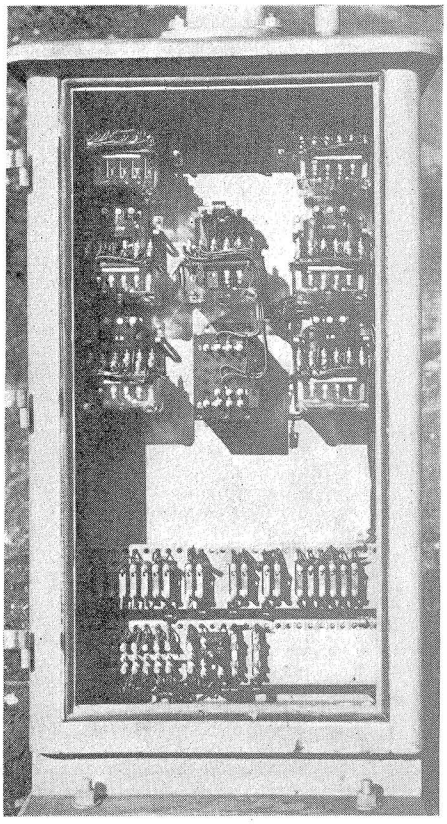
Single-conductor No. 9 underground cable is used for the runs from instrument cases to the rail connections. Raco bootleg outlets are used with stranded connections extending in duplicate to bonded taps to the rails. The runs to switch machines and signals are in underground multiple-conductor cables as required, No. 14 wires being used for control circuits and No. 9 for switch motor circuits. The line drop cables from the crossarms to the cases are in manufactured braid-cover aerial cable, either 10, 12, or 15 conductor. The messenger wires are No. 8 galvanized iron.

At the line pole, each cable terminates in a Raco cast-iron pole box, on the line side of which is a General Railway Signal Company's Type No. 29284-2-GR-2 lightning arrester and Type K-1-A-6 transformer.

Cable and insulated wire was furnished by the Kerite Insulated Wire and Cable Company and both bare and weatherproof copper line wire was furnished by the Anaconda Wire & Cable Company.

Pole Line Construction

The existing pole line was reconstructed throughout the territory, new poles being used to replace those which were decayed or which were too short to provide adequate clearance at crossings. Approximately 80 per cent of the poles were thus replaced using Class-5 pine poles treated with creosote full length. New and replaced guying was installed at numerous locations.



New 6, 8 and 10-pin crossarms were added to each pole as necessary to carry the signal line wires. All the new line wires are No. 9 hard-drawn copper. The 220-volt a-c. power wires and the signal line control wires are bare; however, the two C.T.C. line wires have double-braid weatherproof covering. Glass insulators were used except in locations where boys throw rocks or hunters shoot bullets at the insulators. In these locations rubber insulators were installed.

At each switch location there is a telephone which can be connected to either the telephone train dispatching line circuit or to a separate message line which is connected also to the dispatcher's office and to the offices at the various towns.

This centralized traffic control was planned in co-operation with the General Railway Signal Company and installed by the forces of the Virginian Railway under the direction of A. R. Kyle, Superintendent of Telegraph and Signals, and under the supervision of E. Lockhart, Assistant Superintendent Telegraph and Signals. The detail circuit plans and the major items of equipment were furnished by the General Railway Signal Company.