

Railway Signaling



View of "A" Cabin looking west to east portal of Allegheny tunnel — Note train-order signal on side of tower

Centralized Control On the Chesapeake & Ohio

Installation at Alleghany, Va., extends over five miles of double-track territory and replaces three interlockings

THE CHESAPEAKE & OHIO has made an extensive installation of remotely-controlled power switches and signals to facilitate train operations on the five miles of line over the summit of the Allegheny mountains, near Alleghany, Va. This new signaling project combines into one C.T.C. machine the control of facilities formerly included in three interlockings, and in addition, it provides control of signals for directing train movements in this five-mile area. The traffic handled daily over the territory includes 8 passenger trains, 4 manifest freight trains, and from 12 to 16 extra freight trains. In addition, there are return moves of helper engines for some of the tonnage freight trains. Therefore, the total traffic ranges from 30 to 40 movements daily.

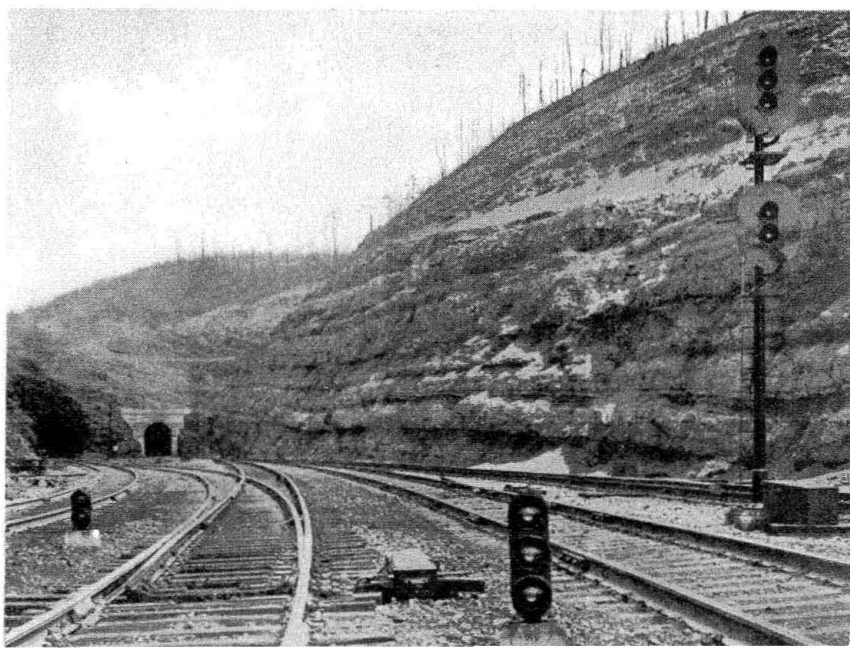
Approaching from the east on an ascending grade of 1.3 per cent, the double-track line passes through Kelly's Tunnel, and about 3,000 ft. west of the tunnel, a center passing siding starts and extends for about one mile westward, with a facing-point crossover just west of the west

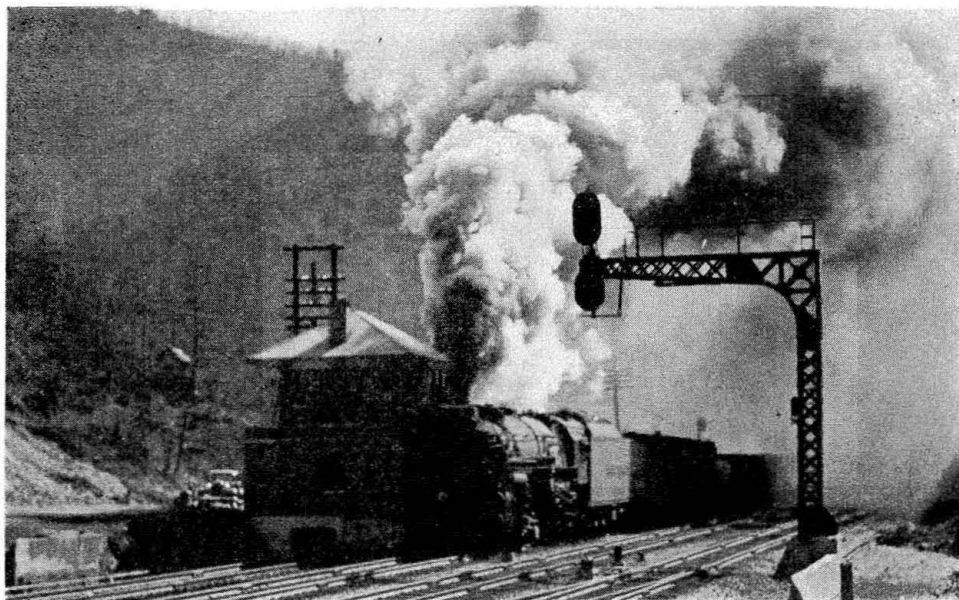
end of the siding. This siding layout, together with an end of double-track for the previous single track westward through the old Lewis Tunnel, was formerly operated by a 24-lever, electro-mechanical interlocking plant known as Jerry's Run. When a second single-track Lewis Tunnel was constructed, the old

tunnel was assigned for the westward track and the new tunnel for the eastward track.

At East Alleghany, at the west end of the old single-track Lewis Tunnel, there was previously a 24-lever, electro-mechanical plant, which included the end of double-track switch and the switches for the east end of two

Electric switch machines and signals at East Alleghany near west end of Lewis tunnel





Westbound tonnage freight train passing "A" Cabin—Home signal 30R in foreground

sidings which extend westward to Alleghany. When the new Lewis Tunnel was completed and the double track extended from Jerry's Run to East Alleghany, the track layouts at these two points were revised accordingly.

At Alleghany, 1.25 miles west of East Alleghany, the track layout includes several crossovers and switches to handle the west end of the two passing tracks and connections to the two main tracks extending westward through the two separate single-track Alleghany tunnels, the summit of the grade approaching from each direction being located about 600 ft. east of the east portals of these tunnels. For eastward tonnage trains, the helper engines are attached at Hinton, W. Va., 51 miles west of Alleghany, and are cut off at Alleghany. For westward trains, they are attached at Clifton Forge, 29 miles east, and are cut off at East Alleghany. The track layouts at Alleghany and at East Alleghany are arranged to facilitate cutting the helpers off and for moves to and from the turntable at Alleghany.

Prior to the installation of the C.T.C. machine, a 32-lever mechanical interlocking machine was in serv-

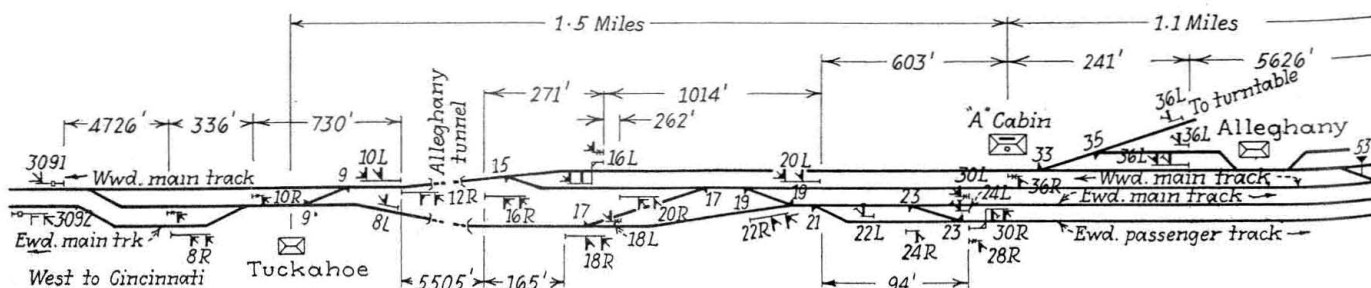
ice at "A" Cabin, Alleghany, to handle the switches and crossovers at the west end of the passing tracks and for controlling the home interlocking signals, including remote control of the signals at the west end of old Alleghany Tunnel, near Tuckahoe, W. Va. During the construction of the new tunnels, temporary changes were made in the track layout at the three old interlocking plants which required a rearrangement of the interlocking facilities, and after the tunnel work was completed, arrangements were made to extend the westward passing siding at Alleghany so that it would hold long freight trains. The extension of this siding made it necessary to rearrange some of the crossovers and switches at Alleghany.

New Interlocking and Remote Control

The track changes in connection with the extension of the westward siding involved major revisions in the interlocking arrangement at Alleghany which would have made it necessary to install a new interlocking machine, and as it was desirable to arrange for train operation in either

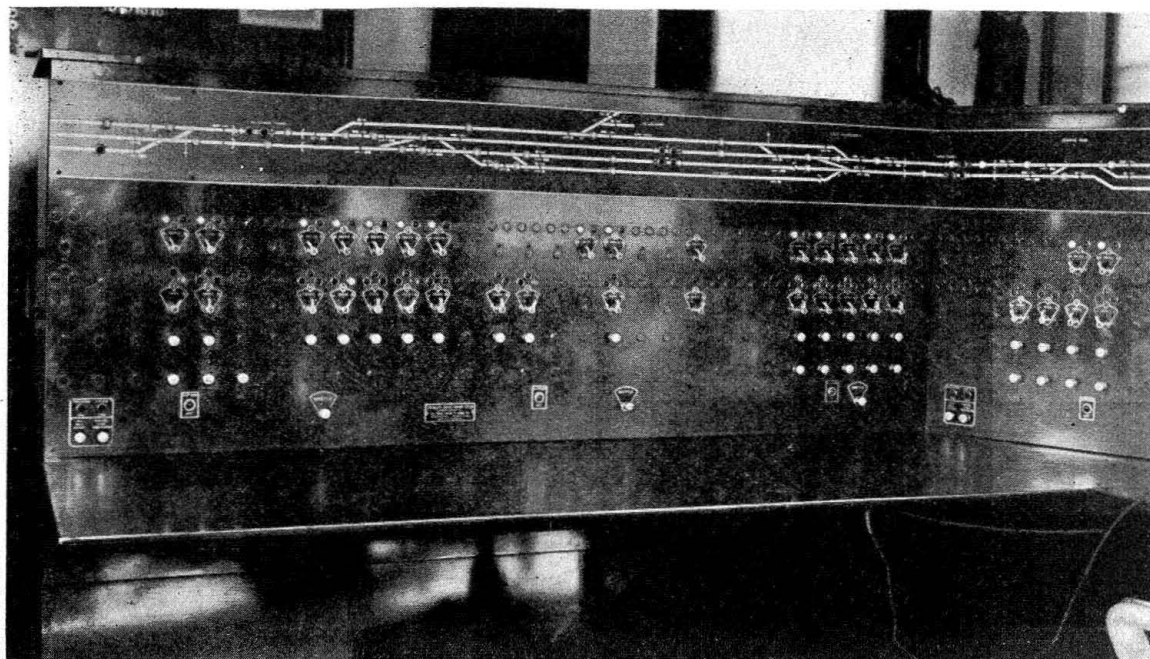
direction by signal indication on both main tracks through the territory—Tuckahoe to Jerry's Run—it was decided that, as a part of the program, the logical procedure would be to abandon the three old interlockings, install power-operated switches and signals, and control all these facilities from a new C.T.C. type machine in a new tower to be known as "A" Cabin, located just west of Alleghany station. By arranging the signals for either-direction operation on the two main tracks, train movements would be greatly expedited in case of land slides or trouble developing in one of the tunnels. Furthermore, it would permit turning one of the tunnels over to track or other forces for certain hours of the day, thus facilitating their work. Another advantage of either-direction operation is that run-around movements can be made, thus keeping all trains moving rather than putting one of them on a siding.

The switches in the general vicinity of the tower are operated by electro-pneumatic switch and lock movements, while low-voltage electric switch and lock movements are used at Tuckahoe, East Alleghany, and Jerry's Run, with the exception of the switch at the east end of the cen-



Track and signal plan of the C.T.C. installation showing the location

The C.T.C. control machine is so arranged that the operator can reach any lever without leaving his chair



ter passing siding at Jerry's Run, which is a spring switch.

The signals throughout the entire territory are the color-light type. All signals are located immediately to the right of the track governed, standard two-arm signals being provided for all through train movements. Color-light dwarfs displaying two, three and four aspects, as required, are used to control slow-speed train movements.

The C.T.C. Control Machine

The C.T.C. type control machine in "A" Cabin is arranged in two panels, the end section at the right being set at an angle with the main section, so that the operator can readily reach any of the levers without leaving his chair. The machine has 15 levers for the control of 7 single switches, 2 derails and 6 crossovers; 23 levers for the control of 44 signals, 2 traffic levers and 4 levers for the control of electric switch locks and as selector levers on hand-operated switches. The levers are of the usual miniature type, each lever being equipped with indication repeater lamps, so that the leverman knows

the position of each switch and the aspect of each signal. An illuminated track diagram, mounted just above the levers, indicates the location of all trains on the main tracks in the five-mile controlled territory.

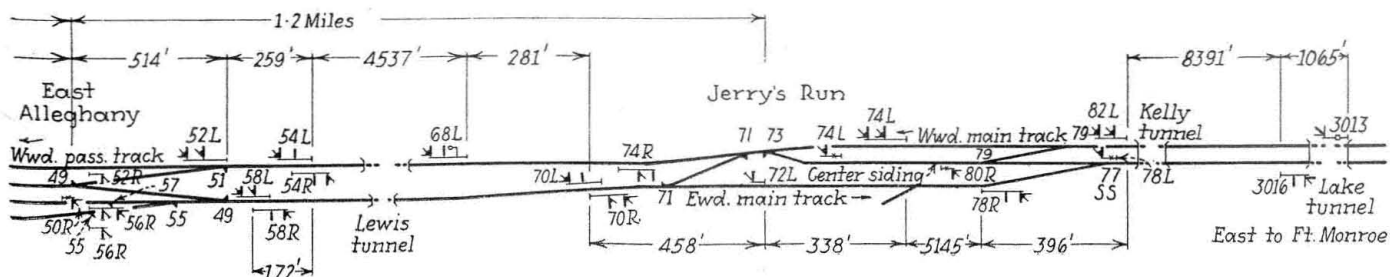
Control of Tunnel Fans

Mounted in a small case to the right of the C.T.C. machine is a one-lever controller used for the control of the ventilating fans for removing locomotive smoke from the westward Lewis Tunnel. Normally, the operation of these motor-driven ventilating fans is controlled automatically by track circuits, as a train approaches the tunnel. However, provision was also made for the fans to be operated manually when desired. This is accomplished by the operator at "A" Cabin throwing the lever to the "down" position to cause the fans to operate independent of the track circuit control. On the other hand, when a passenger train is being operated through the tunnel, for which it is not necessary for the fans to be operated, the operator can offset the track circuit control and prevent the fans from operating by throwing the

lever to the "up" position. A yellow lamp on the C.T.C. machine is lighted when the fans are in operation, and a red lamp is lighted when the fans are not in operation. The control of the fan is by direct wire, but the indications, between the fan house at the tunnel and "A" Cabin, are transmitted as a part of the code control system.

Train Order Signal Control

"A" Cabin is a block office for the delivery of train orders when required. Two color-light type signals, one for eastward movements and the other for westward movements, are mounted on the track side of the tower, and are designated as train order signals. These signals are controlled by a small two-lever controller mounted on the operator's desk at the right of the C.T.C. machine. The levers are normally on center and the signals normally dark, indicating no orders. When the lever is thrown down, the signal displays a yellow aspect indicating that a non-restricting "19" order is to be delivered, but when the lever is thrown up, the signal displays red indicating that the



of the three track layouts at which interlockings were formerly in service

train is to stop for a "31" or restricting "19" order. The aspect displayed by either signal is repeated on the controller so that the operator knows that the signal aspects correspond to the position of the lever, and he also has a check against a burned out lamp bulb. Under normal operating conditions, train movements in the territory from Jerry's Run to Tuckahoe are directed by signal indications without written train or-

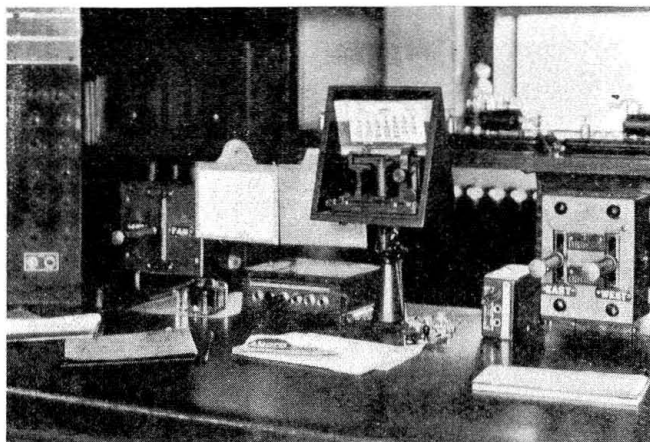
sure drops below 50 lb., the second compressor also cuts in.

The power equipment, including enclosed type switches, circuit breakers, transformers and rectifiers, is mounted on a large board made of asbestos sheets attached to angle-iron uprights. The wires running to the devices on this board are in metal conduit with outlets at each device, as shown in one of the illustrations.

Each of the two relay racks in this

fibre ducts in the concrete floor which open into a pit beneath the rear of the relay racks. The individual insulated wires of the cables are brought up the rear of the asbestos terminal board.

Each cable wire is run through an individual hole and attached to its corresponding terminal on the terminal board. From these terminals, a wire extends back through a hole to the rear and then is run in the made-up cables to the place where it passes through another hole and out to the terminal near the relay where it terminates. The identification tag for each wire is attached with glue against the wall of the rack, as shown in the view. This interior wiring is No. 16 flexible. The made-up cables



Special levers are used for the control of the tunnel fans and the train-order signals

ders. The orders, when issued at "A" Cabin, are ordinarily with reference to moves or track conditions beyond the control zone.

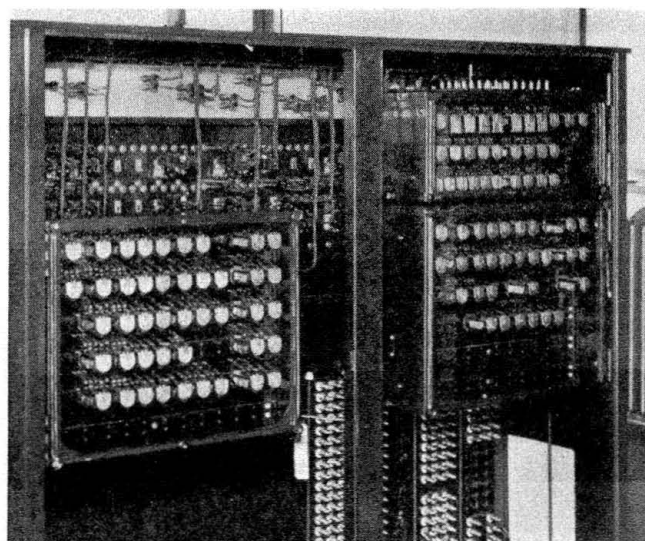
Construction at "A" Cabin

The switches and signals throughout the area from the east portal of Alleghany Tunnel eastward to Alleghany station are controlled by direct wire connections. However, the code control system, using only two line wires, is used for the control of the functions at East Alleghany and Jerry's Run. A separate two-wire code circuit extends westward for the control of the switches and signals at Tuckahoe.

The section of the installation in the general vicinity of "A" Cabin, although a part of the complete C.T.C. project, is in reality an electro-pneumatic interlocking, employing the all-relay principle, so far as interlocking of the functions is concerned.

The compressed air for the operation of the 10 electro-pneumatic switch machines is furnished by a 12.5-cu. ft. compressor driven by a 2-hp., 220-volt, 3-phase motor, operating at 1,410 r.p.m. A duplicate motor-driven compressor is provided for stand-by or alternate service. Each motor is controlled by a twin-break starter, controlled automatically by the pressure in the air lines. The compressor on first call cuts in when the air pressure drops to 55 lb. and cuts out at 75 lb. In case the pres-

The code equipment at "A" Cabin is housed in the rear section of the control machine



tower is 12 ft. long and has 9 shelves set 15 in. apart. The racks are made up of angle-iron frame work with $\frac{1}{2}$ -in. asbestos board for the shelves and $\frac{3}{4}$ -in. for the rear walls. The corner supports of the frames are made of 2-in. angle-iron, and the cross pieces under the front and rear edges of the shelves are $\frac{3}{4}$ -in. angle-iron, with $\frac{1}{2}$ -in. by 2-in. straps run as supports for the shelves. The various parts of the frame were welded together in place as constructed. The uprights at the rear of the racks are set behind the asbestos board, as shown in one of the views. As a support for the wiring, $\frac{3}{8}$ -in. round iron rods are attached to brackets set out 4 in. from the rear uprights, the wires being made up into cables suspended from these cross rods. The relay racks are set back to back with a 3-ft. 6-in. aisle between. In the east end of this aisle, an asbestos wall is used as a terminal board.

The incoming underground cables are brought into the tower through

extending from the relay racks up to the machine are enclosed in chases made up of asbestos board.

The 2-in. pipe line for the distribution of the compressed air for the operation of the switches is run along the north side of the tracks, being supported on stakes. Each stake is made of a piece of 2½-in. angle-iron set in concrete, the pipe being supported in a hook made of ½-in. by 2-in. strap iron. When constructing the line, the stakes were set, the pipe was distributed, and connected up, screwclamps were used temporarily to hold the hooks to the stakes, the pipe was then set in place, and the hooks adjusted up or down on the stakes so as to aline the pipe properly. The hooks were then welded to the stakes permanently, and the clamps removed.

The local wiring distribution over the plant area in the vicinity of the tower is in steel-taped cable run in cable rings suspended from stranded messenger attached with special brackets to the same stakes used for

the support of the main air line, the cables being run at the same level as the pipe line, about 12 in. to 15 in. above the level of the ground. The main cables are run on the communication pole line.

At certain points, as required, the main cables enter junction boxes or instrument cases, from which underground steel-taped cables extend to the various switches, signals or track

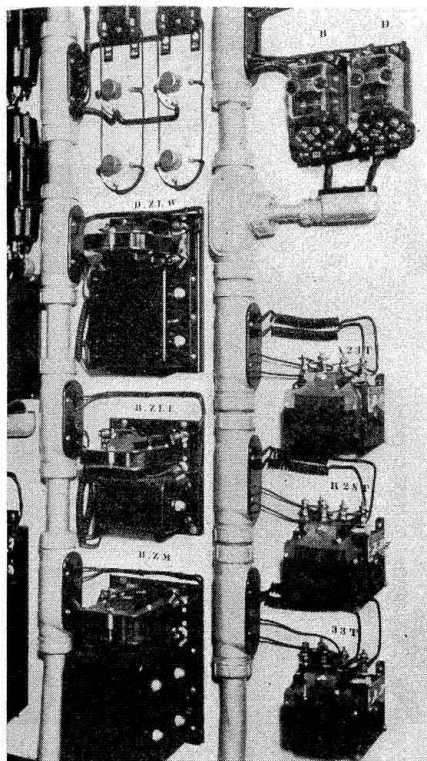
and fastened to either side of the rail by means of a rail terminal which consists of a $\frac{3}{8}$ -in. plug threaded on one end and equipped with an eyelet, cupped washer and nut. The connection at the rail and the plug is treated with a coat of No-Ox-Id, to prevent corrosion.

Construction at Outlying Points

Beyond the limits of the Alleghany area, the control of the switches and signals is accomplished by the time-coding system in contrast to the direct-wire control in the Alleghany area. Furthermore, in the remote areas, low-voltage d-c. electric switch

The a-c. power for this territory is distributed at 440 volts, single-phase, this circuit being marked on the end of each crossarm with 2-in. aluminum markers. At each signal location a 440/115 volt line transformer is mounted on the crossarm and each transformer layout is protected by pellet-type arresters and fused cut-outs. The line taps are made with solderless clamp-type connectors. The machine at "A" Cabin is equipped with indication lamps to show when power is cut off at each of the four locations; namely, Tuckahoe, Alleghany, East Alleghany and Jerry's Run.

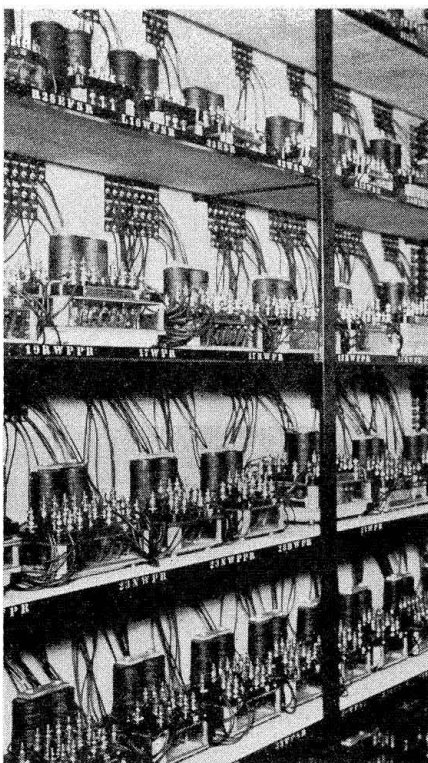
The signals are normally a-c. lighted, and the power line also furnishes current for operating the rectifiers which charge the various sets of storage battery. At each of the field stations, a set of 13 cells of 112-a.h. capacity lead battery is used for the operation of the switch machines, 8 of these cells being used also



The rectifiers and other power apparatus are mounted on a special panel

connections. The instrument cases are of the welded sheet-metal type with two hinged doors at the front and, at the rear, two removable panels provide access to the wiring space behind the terminal board. As a means of protecting the incoming cables at the ground line, the cables are brought up through a vitrified clay tile, and after the cables are in place, the void space is filled with sand and sealed at the top with about one inch of pothead compound. The No. 14 AWG solid copper, steel-taped cables for switch and signal wiring are made up with two wraps of steel tape and jute covering.

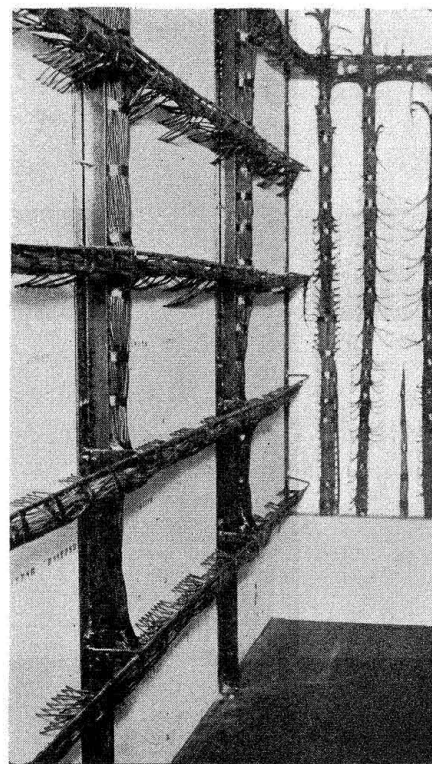
For rail connections, single-conductor No. 9 AWG solid copper, steel-taped cables are used, the make-up including two wraps of steel tape and jute covering. At the rail, this cable is brought up through a wooden box riser, the wire end being soldered to two lengths of No. 9 flexible insulated wire, each of which is run out through a hole in the top of the riser



The racks are made up of asbestos board on angle-iron frames

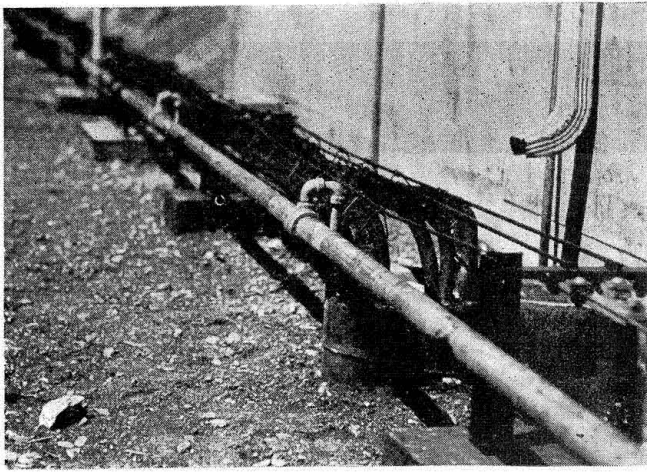
machines are used, instead of electro-pneumatic machines as employed at Alleghany.

The signal, code and power line wires in this territory are carried on a 10-pin crossarm mounted below the crossarms which carry the communication line circuits on the pole line. They are all protected with double-braid, weatherproof covering, the signal control wires being No. 10 AWG copper-covered steel, and the two code wires, as well as those for the 440-volt a-c. power distribution, are No. 6 AWG, hard-drawn copper. Porcelain insulators are used for the 440-volt line, brown type pyrex glass insulators for the code circuit and ordinary glass insulators for the signal control circuits.



The wiring at the rear of the racks is cabled

for code operating battery. Five cells of 168-a.h. or 224-a.h. capacity lead-type battery, as required at the various locations, are used to feed local control relays and to act as a stand-by for the signal lamps. Two sets, one of 12 and one of 7 cells of 8-a.h. capacity lead-type battery, located at "A" Cabin, are used to feed the code lines east and west of "A" Cabin, respectively. Each track circuit is operated by one nickel-iron



Cable is run on messenger at the pipe-line level

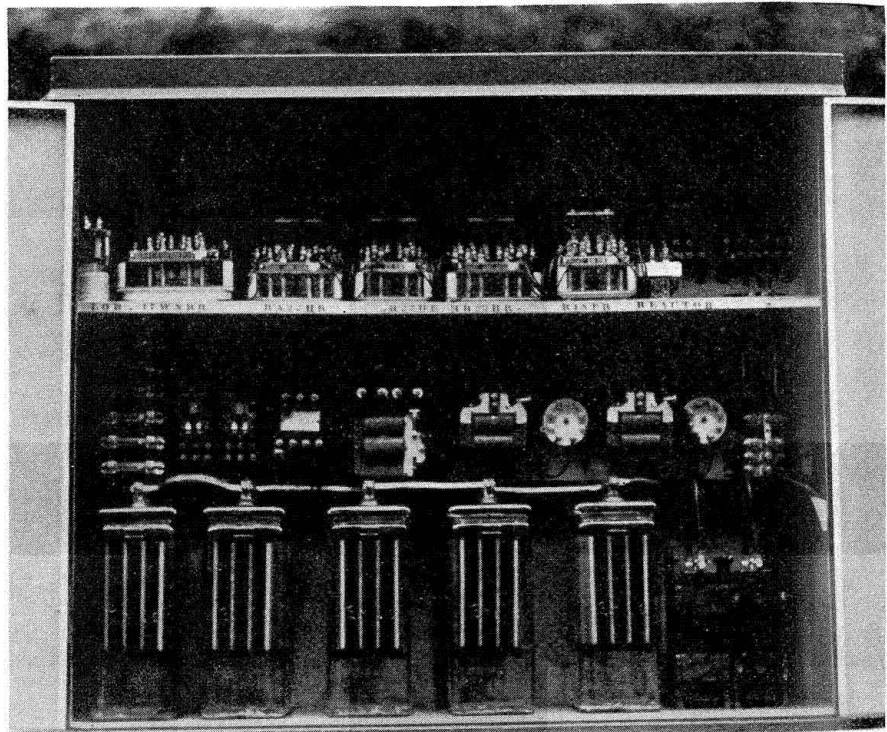
Sheet-metal cases house the instruments and battery at the home signals

storage cell. Each battery is on floating charge through a dry-plate rectifier.

The field control batteries, relays, rectifiers and equipment, including coding apparatus, are located in four centrally located houses, one at the east end of Jerry's Run, one at the west end of this layout, one at East Alleghany and one at Tuckahoe. Each of these houses is 8 ft. wide and of varying lengths from 9 ft. to 14 ft., of frame construction, using 2-in. by 4-in. studdings, and 1-in. by 8-in. shiplap siding and roof. The outside walls and roof are covered with heavy gage corrugated galvanized sheet iron. The foundation and floor are in one piece, made of concrete poured in place.

In order to allow space for a man to get behind the relay racks in the house, those on the rear and two sides are set out 20 in. from the wall. The racks are built up solid from the floor to the ceiling, of 1-in. boards bolted to $\frac{1}{2}$ -in. by 2-in. by 2-in. angle-iron uprights. All incoming cables and wires are brought into this outer compartment, and the wires are run through small holes to bakelite base terminals, which are mounted on the rear wall of the relay rack. The interior wiring is No. 16 flexible with $\frac{1}{32}$ -in. insulation wall and single braid. Distributing wires from the terminals to the various instruments are run back through the wall, thence on messenger rods in the wire-way to a point where they again pass through holes to the binding posts on the instruments. In this way all the wiring runs are out of sight, and yet there is adequate space behind the racks to install or inspect the wiring. All terminals, arresters, limiting resistances, fuses, etc., are mounted on the rear wall of the terminal rack.

A 5-ohm adjustable resistor is used for each track circuit, and a 3.5-ohm adjustable resistor is used for each signal lamp circuit. The battery connections to the code units are fused



with 6-amp. fusetrons. The signal line control circuits are protected by series line clock-coil type arresters, and the track relays are protected by shunt-type arresters with the center tap grounded. These arresters are connected to grounds used exclusively for this purpose, being separate from the ground for the arresters on the 440-volt circuits.

The lightning protection for the code line is of special interest. At each instrument house the following combination is used: Neon Argon arresters are connected in series and are located in a box on the line pole. Number 60 AP arresters with carbon blocks are connected across the line and are located in each instrument house and in the tower at "A" Cabin. This arrangement of arresters has proved very successful in preventing failures of the code line which might otherwise be caused by lightning. For testing or changing out code ap-

paratus, the code line equipment at any of the outlying field stations can be by-passed by reversing a knife switch which cuts off the line coding unit and inserts a 20-ohm resistance in series with the line.

Relay Assignments

The track relays are of the DN-11 type, using 4-ohm relays for short detector sections and 2-ohm relays for normal length circuits. The line control relays for the three-position automatic signals are the DP-21 retained-neutral polarized type rated at 400 ohms, and DN-11, 500-ohm re-

lays are used for the control of other signals. The code-repeater stick relays are also 500 ohm, and as their holding circuits are energized from the 16-volt, code-operating battery, fixed 500-ohm resistance units are inserted in series to reduce the voltage across the coils of the relays. Type DP-14, 500-ohm relays with special front contacts are used to control the motor circuits of the switch machines. An ANL-2 relay is connected in series with the red lamp in the top unit of each two-unit, color-light home signal, so that if the filament burns out, the red lamp in the bottom unit is lighted automatically. Approach and time locking is accomplished by TH-10 thermal relays.

This change-over from electro-mechanical interlockings to power switches and signals, controlled remotely from the C.T.C. machine, was planned and installed by the signal forces of the Chesapeake & Ohio.