This view shows eastward signal 462 on siding at Beech Creek

C.T.C. Saves Train Time on the Pennsylvania

On about 50 miles of track, the average road time of through freight trains has been decreased 36 min. eastward and 59 min. west

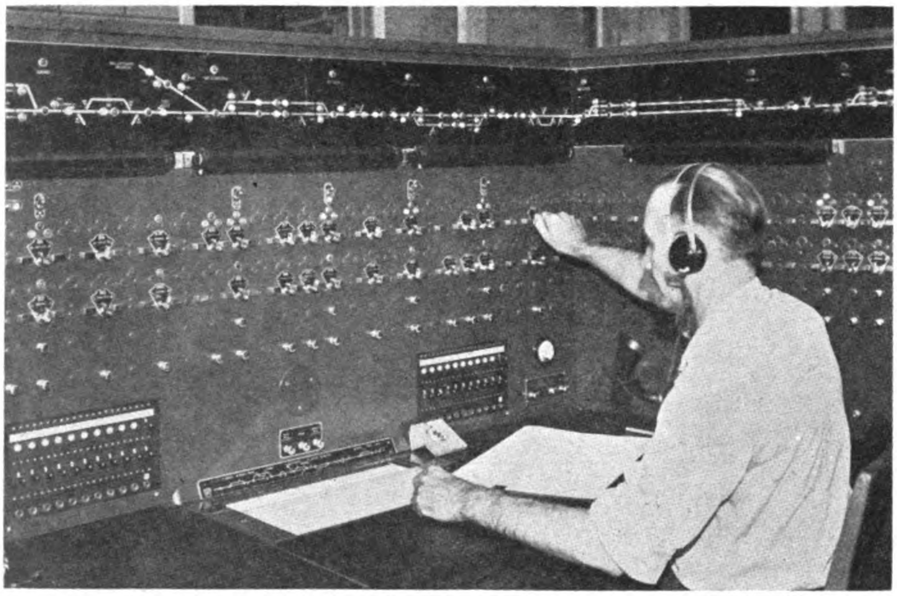
THE Pennsylvania Railroad has installed centralized traffic control on 5 miles of two main tracks and on 47.7 miles of single track on its Bald Eagle Branch, which extends from Tyrone (Park), Pa., to Lock Haven, Pa. Tyrone is 116.6 miles west of Harrisburg on the route between New York and Pittsburgh, and Lock Haven is 118 miles northwest of Harrisburg on the route between New York and Buffalo via Harrisburg.

Tyrone is located on the Juniata river at an elevation of 806 ft. above sea level, and Lock Haven is on the Susquehanna river at an elevation of 554.9 ft. From Tyrone, the Bald Eagle Branch ascends eastward at 0.6 to 0.8 per cent for about 8 miles to Dix, from that crest, at an elevation of 1,110.3 ft., the railroad follows down the valley of the Bald Eagle creek all the way to Lock Haven, the line descending gradually at water grade, although there are a few easy rolling grades on short-cuts through open portions of the valley. Curves are fairly numerous but none is sharp enough to limit freight train speeds below 45 m.p.h., which is the maximum authorized freight speed for this territory. The maximum authorized passenger train speed is 60 m.p.h., and on six curves the speed is reduced to 45 m.p.h. The track is well constructed and maintained, with 130-lb. rail, good ties and crushed rock ballast.

Heavy Freight Traffic

A considerable volume of through freight traffic is handled on the Bald Eagle Branch which is a part of a route from the West to cities in upper New York, Canada and New England via Lock Haven, Williamsport, and Wilkes-Barre. About 75 per cent of the eastward traffic consists of loaded coal cars, which return westward empty. About six or seven coal trains are operated eastward daily, and the same number of trains of empty coal cars westward. By providing a helper locomotive from Tyrone eastward 8 miles up the grade to Dix, the road locomotives handle about 7,000 gross tons, ranging from 90 to 100 cars. In addition to the coal trains there are five preference merchandise freight trains each way daily, which handle from 4,500 to 5,000 gross tons. A local freight is operated each way daily except Sunday, and a local passenger train makes a round trip daily. The traffic varies on different days of the week and in different months of the year, so that the number of trains ranges from 25 to 30 daily.

Operating results under C.T.C. sys-



The C.T.C. control machine in the office at Milesburg

tem have been as follows: (1) Stops and slow-downs have been reduced; (2) Average road time per freight train has decreased 36 min. eastward and 59 min. westward; (3) Average speed of freight trains has increased 2.8 m.p.h. eastward and 4.0 m.p.h. westward; (4) Capacity of the line has increased.

Layout of Sidings

A main track and a siding extend east from Tyrone (Park) 1½ miles to Vail. Also a main track and a siding extend from Lock Haven west to Post. Some years ago a second main track on a more favorable grade and different alinement was constructed between Wood and Sand, 5 miles. The remainder of the line between Vail and Post is single track. Between Wood and Sand the tonnage trains are routed over the new line, and other through trains of both directions are routed over this new line if it is available, otherwise they go over the old line. The station at Howard is located on the old line, and, therefore, the local freight and the passenger train are routed that way.

Long sidings used for the meeting and passing of trains are located at Eagle, Julian, Milesburg and Beech Creek, as shown on the diagram herewith. Prior to the installation of C.T.C., there was an interlocking at Wood, with a power switch machine and signals at Sand remotely controlled from Wood. A mechanical interlocking at Milesburg included the switch at the east end of the siding as well as the junction switch leading to the short branch up to Bellefonte. Mechanical interlockings which also served as block stations were in service at Eagle which is the west end of Eagle siding, at Port Matilda, from which the east end of the siding was remote controlled, and at Mill Hall (M.P. 50) for control of a siding since removed. Spring switches were in service at Baker, which is the west end of the Milesburg siding, at the east end of the Julian siding and at the east end of Beech Creek.

Train movements were authorized by timetable, train orders and manual block with offices open three tricks at Park, Eagle, Port Matilda, West Julian, Milesburg, Wood, Beech, Hall and Lock Haven. The spring switches, block stations and interlockings at Eagle, Port Matilda, West Julian, Wood, Beech and Hall were removed after the installation of centralized traffic control, which includes power switch machines and semi-automatic signals for directing train movements at both ends of three long sidings, at both ends of the two main tracks between Sand and Wood, and at the end of the siding at Vail and at the junction switch at Milesburg. All of this territory is controlled from the C.T.C. machine in the new office at Milesburg. The new power switch and signals at the end of the siding at Post are controlled from the tower at Lock Haven.

Signals and Signaling Arrangements

The signals on this installation are the position-light type, and display aspects according to the A.A.R. Standard Code. Every signal is at the im-

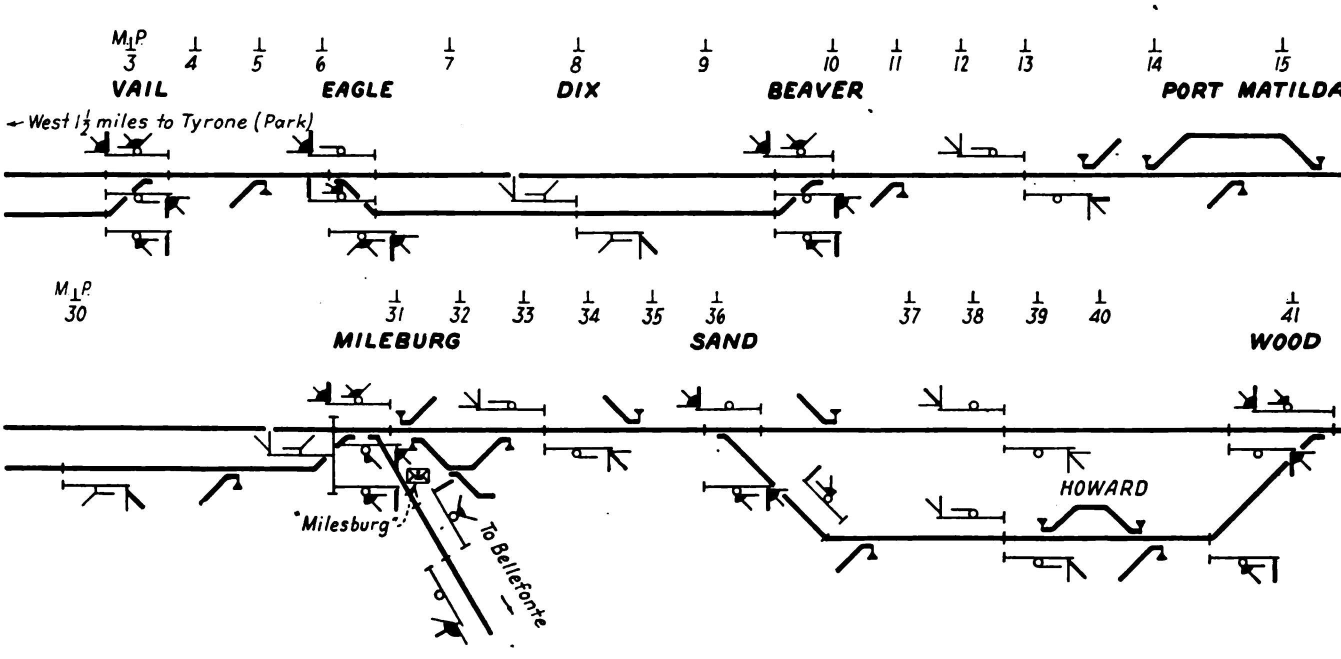
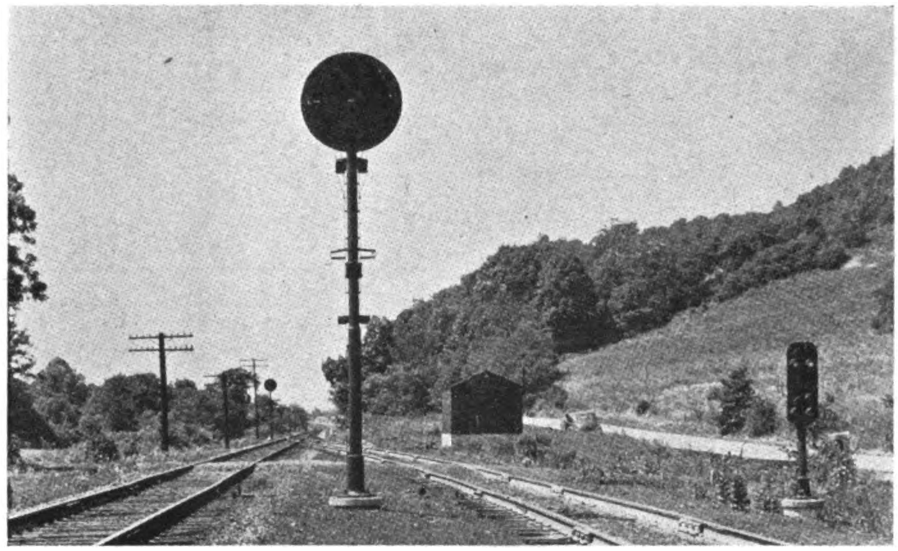


Fig. 1—The track and signal plan of the centralized traffic

mediate right of the track governed, and in order to comply with this practice, at one end the siding was thrown over to 20-ft. centers in order to locate the station-leaving signal for the main track between that track and the siding.

The leave-siding signals are not dwarfs, as this term is ordinarily applied, but rather the pedestal type, being mounted on short masts high enough to bring the lowest lamp 3 ft. 10 in. above the level of the base of the rail. These pedestal signals can be located between tracks on 15-ft. centers without fouling the clearance limits, and they provide better visibility.

The intermediate signals are, in most instances, arranged as double locations. Where the distance between sidings ranges from 7.5 miles to 10 miles, there are two double locations of intermediate signals. Where the distance is about 5 miles, as for example between Milesburg and Sand, there is one location of intermediates. Where the distance is short, as for example 3 miles between Vail and Eagle, there is no intermediate signal, and in this instance, the leaving signal at Vail is the distant signal for the entering signal at Eagle, and the leaving signal at Eagle is the distant signal for Vail.



Westward signals at west end of siding at Julian

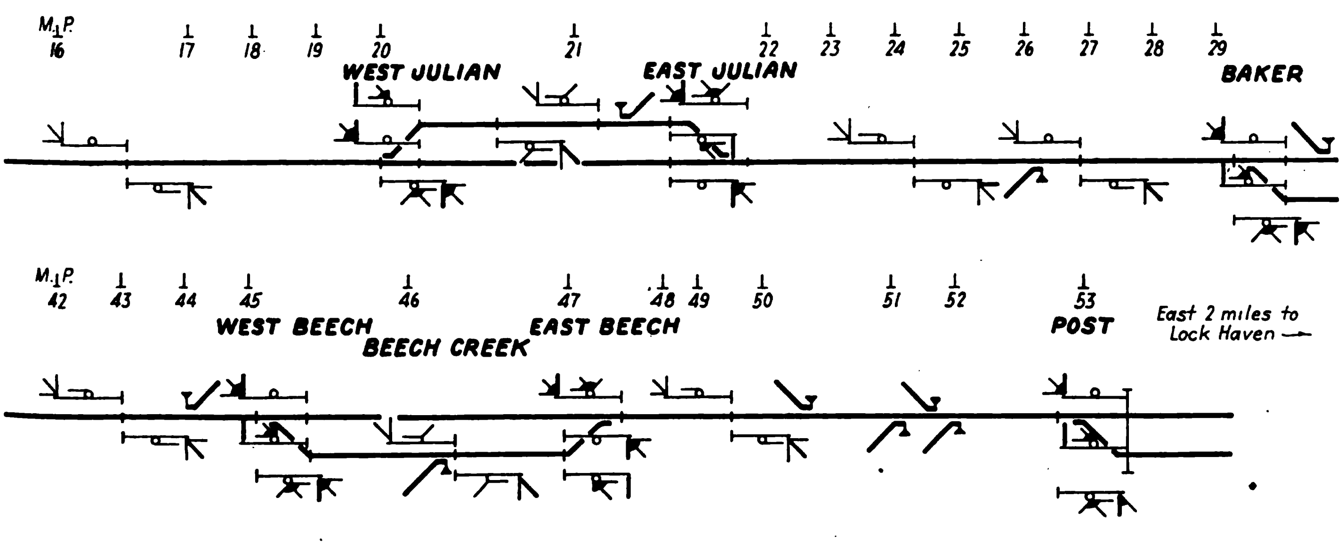
Sidings Are Signaled

Interesting features of this C.T.C. project are the signals to facilitate movements into and out of the sidings, as well as the signals on each siding to permit a following train to be moved into a siding. An important point is that the sidings are long, 234 car capacity at Beech Creek, 137 cars at Milesburg, 144 cars at Julian and 408 cars at Eagle. The length of these sidings improves the chances to make non-stop meets between opposing trains, and a second advantage is that, except for the very long trains, two trains of the same direction can be closed in on a long siding when meeting an opposing train.

The turnouts at the ends of the sidings are No. 15, good for train speeds of 30 m.p.h. when entering, and the signaling permits enginemen to bring their trains up to and through the turnouts onto the sidings at this speed, thereby saving train time as compared with operation under control, prepared to stop at the entering signal or at any point within range of vision on the siding.

The sidings are equipped with track circuits for the automatic control of signals, depending on track occupancy as well as C.T.C. lever control. When a switch is reversed and the signal lever operated for a train to enter a siding which is unoccupied, the distant signal to the siding displays the Approach-Medium aspect, Rule 282, which indicates "proceed, approaching next signal at medium speed." The home signal displays the Medium Clear aspect, Rule 283, which indicates "proceed; medium speed within interlocking limits." Thus the engineman can, with safety, bring his train up to and through the turnout at medium speed, making reduction in speed on the siding as required by indication of the intermediate signal.

The next item of interest is the provision of intermediate signals on the sidings, which serve as distant signals for the leave-siding signals as well as to space trains on a siding. These in-



control territory between Tyrone and Lock Haven termediate signals on the sidings are the pedestal type with two operative "arms." Referring to Fig. 2, showing the Beech Creek siding, the eastward intermediate signal on the siding is No. 462. When the leave-siding signal at the east end of the siding is displaying the Stop aspect, then signal 462 displays the Approach aspect.

With a Train on the Siding

The sketch in Fig. 3 shows an eastward train stopped on the siding east of intermediate signal 462, which is displaying the Restricting aspect, this being the most restrictive aspect displayed by such a signal. In this instance, if the west switch is reversed and home signal 42L is cleared for a second eastward train to enter the siding, then this home signal 42L displays the Slow-Approach aspect, Rule 288, indicating "proceed prepared to stop at next signal; slow speed within interlocking limits." If the rear of the first train has not passed signal 462, as shown in Fig. 4, then the home signal 42L can be cleared to display the Restricting aspect, Rule 290, to allow the second train to pull in on the siding at restricted speed prepared to stop short of train ahead.

When Departing From Siding

When a train, on a siding at a location shown in Fig. 5, is to depart, with no train ahead for two or more blocks, the switch is reversed and leave-siding signal 26L is cleared to display the Medium-Clear aspect, Rule 283, indicating "proceed; medium speed within interlocking limits." After the rear end is out on the main track, the train can be accelerated to authorized speed. If a preceding train of the same direction has cleared only one block, the leave-siding signal 26L in Fig. 5 can be cleared to display the Slow Approach aspect.

Referring to Fig. 6, with an eastward train on the siding west of the intermediate signal 462, and with the east switch reversed and leave-siding signal 26L cleared to display Medium-Clear, then intermediate signal 462 on the siding displays the Approach-Medium aspect. This permits the engineman to accelerate his train promptly, with the knowledge that he is to pull out through the turnout at medium speed. This is a help, especially where sidings are on curves with mountains that obstruct the view ahead. Thus the signaling provided to direct trains when entering, departing or moving on the sidings, is an important factor in facilitating such movements. Incidentally, the track circuits on the sidings are also used to control track-occupancy indicator lamps on the track model on the C.T.C. control machine, and these indications are helpful as a reminder of the fact that trains are being held on sidings.

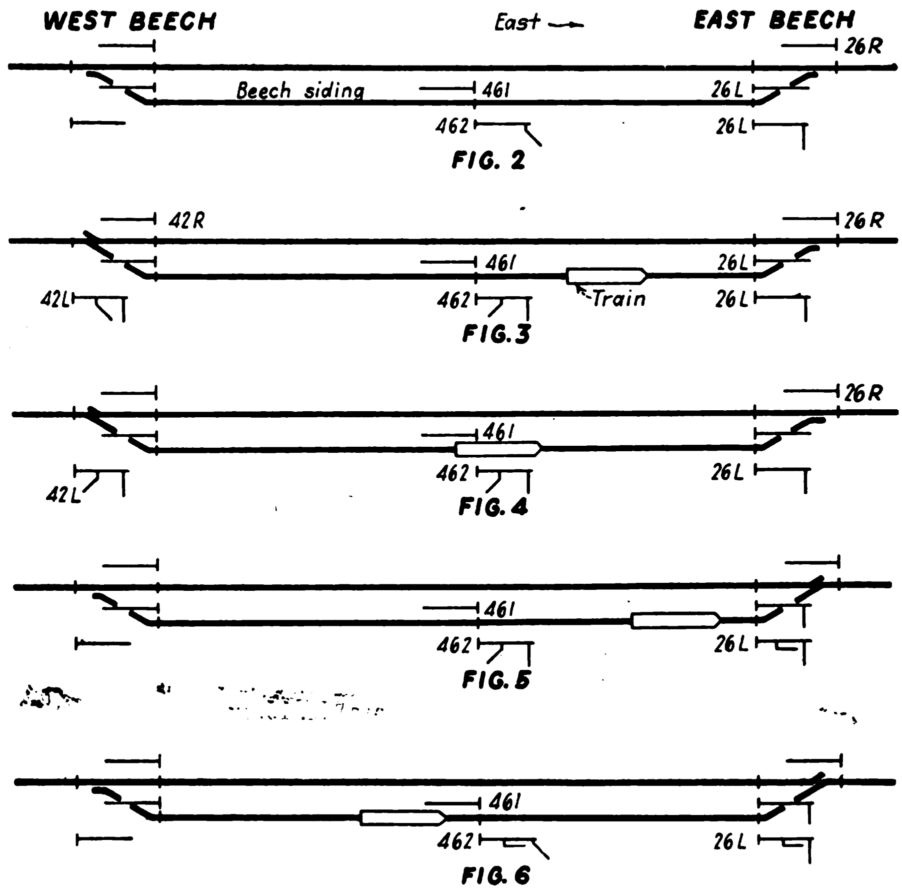
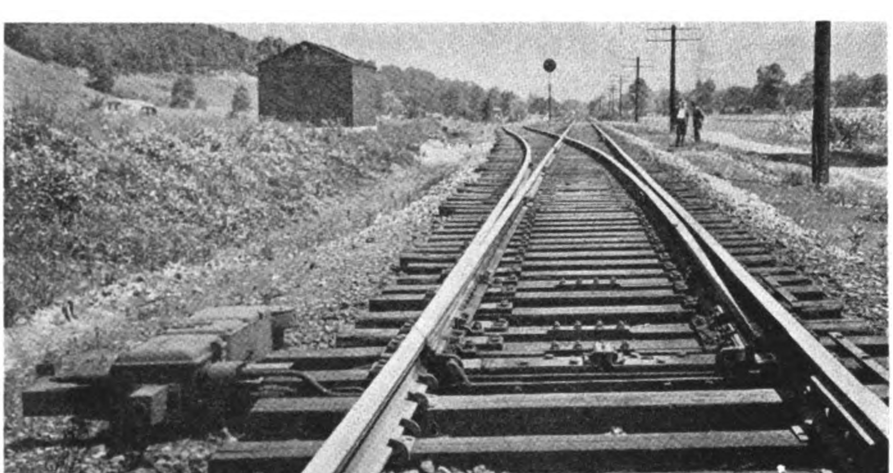


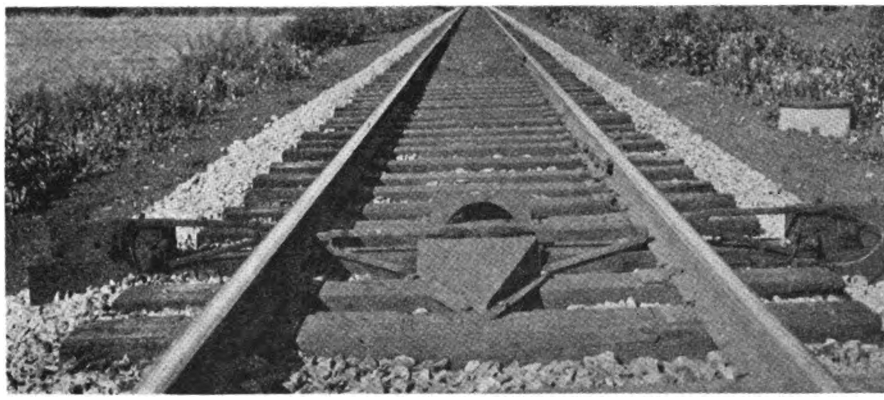
Fig. 1 to 6—Illustrating use of signals on a typical siding

Construction at Switches

At each main-track switch there is a 1¼-in. by 7½-in. insulated gage plate on the first tie under the points. Adjustable rail braces are used on this tie and the next two ties under the points. The power-operated switches are equipped with electric switch machines for operation on 24 volts d.c. At other main-track switches leading to house tracks or industry spurs, the old hand-throw stands were replaced with hand-operated switch-and-lock movements which mechanically lock the switches in the normal position similar to the arrangement in inter-



The power switch layouts are well constructed with heavy insulated gage plate and adjustable rail braces on three of the crossties



Each installation of dragging equipment detectors consists of four cast-iron arms which are mounted in a circuit to control signals to restrictive aspects when arms are broken

lockings. These mechanisms are equipped with electric locks which are controlled as a part of the C.T.C. system. From each of these mechanisms, a pipe connection extends to and operates a derail located at clearance on the turnout. At each of these hand-throw switches there is a low target including a lamp, this target being on a separate foundation, and is operated by a rod extending to the switch.

Dragging Equipment Detectors

As a part of the signaling project, dragging equipment detectors were installed at locations in approach to certain switches, a total of six detector locations being included. The reason for locating the detectors in approach to switch layouts is that the turnout rails may deflect dragging equipment onto a running rail under the wheels, thus causing a derailment. As illustrated in one of the accompanying pictures, each detector installation includes four cast-iron arms, which are in a circuit connected with the control of signals. Defective brake beams or other parts, hanging or dragging from a train, will break one of these arms, and thereby operate the signals to restrictive aspects so that the train can be stopped for inspection. In some instances, ice hanging from cars has broken a detector, thus causing train stops and delays needlessly. For this reason a row of discarded air hoses is placed vertically, in a row across the track, about 600 ft. in approach to each detector, for each direction.

The C.T.C. Control Machine

The C.T.C. control machine for this territory is located in a new one-story brick building at Milesburg. Referring to the picture of this building, the concrete canopy is designed so that during the summer the sun will not shine on the windows, but during the winter, when the sun is lower in the horizon, it will shine through the windows. The windows are thermopane glass to reduce glare and transmission of heat as well as light.

The C.T.C. machine consists of one 5-ft. center panel with a 2.5-ft. wing section on each end. Several features of this C.T.C. control machine are different from conventional practice as used on other railroads. In addition to the conventional practice of providing a track-occupancy lamp corresponding to each section of main track between sidings and each OS detector track circuit at power switches, this track model also has track-occupancy lamps to correspond with each siding and each section of main track opposite a siding.

Traffic Direction Indicators

This C.T.C. installation includes coded track circuits which not only detect the presence of trains but also are fed at different rates, such as 75, 120 or 180 times each minute to control the signals to display different aspects; therefore, this practice eliminates the use of line wires for the automatic control of signals. A detailed explanation of this use of coded track circuits was published in the August, 1944, issue of *Railway Signaling*.

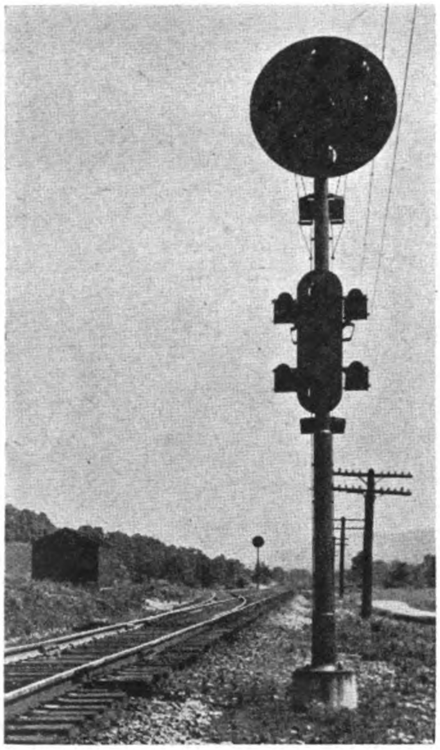
The coded track circuits in a station-to-station block must feed in the direction opposite to the train for which the signal is to be cleared, and the direction in which they are to feed is established by a traffic-direction lever for the corresponding section of track, these levers being mounted in the same horizontal row with the signal lever in the C.T.C. machine.

Each such section of track, as represented on the track model, has a traffic-direction indicator which consists of a double-pointed arrow, including two blue lamps. When a traffic-direction lever is thrown to the left, the traffic on that section of track is set up eastward, and the lamp to the left is lighted; or thrown to the right, to establish traffic westward, lighting the lamp to the right.

Levers and Indication Lamps

Each C.T.C. controlled signal is represented by a symbol including a green lamp which is lighted when the signal has been cleared. This obviates the ordinary practice of two other lamps above the lever, one to repeat eastward and the other westward signals. On the other hand, on this Pennsylvania machine there is a red lamp above the center position of each signal lever which is lighted when all the signals controlled by that lever are at Stop. When necessary to close a train in on another train which is occupying track circuits which control the signal, a call-on aspect can be displayed by positioning the levers

At industry spurs the switches are operated by hand-operate switch-and-lock mechanisms which also are pipe-connected to derails at the fouling point



Eastward signal at West Julian

and pulling the small button, which is held out mechanically, just below the signal lever and pushing the conventional code-starting button just below.

Each switch lever has a yellow lamp at the left to repeat the normal position, and a green lamp at the right to repeat the reverse position of the switch, and, in addition, a red lamp in the center is lighted when electric locking is in effect to prevent operation of the switch even if the lever were thrown.

Indications of Dragging Equipment Detectors

On the diagram, at each place corresponding to the location of a dragging equipment detector, there is a white lamp which is lighted when the corresponding detector is actuated, and a buzzer also is sounded. At the same time, if the signal controlled by the detector had been cleared, that signal is automatically returned to the Stop aspect, and the green lamp in the symbol for the signal is extinguished. After the train has been stopped and inspected, and the conductor telephones the operator that the train is ready to proceed, the operator breaks a seal on a small toggle switch lever above the switch lever and signal lever for that location, and throws this toggle switch lever to the down position. The result is that a code control is sent out which cuts out the control of the detector, and, therefore, the operator can again clear the signal, although a detector arm is still broken. In the meantime, the maintainer had been called, and when he replaces the broken section of the detector, and operates a push-button, thus restoring the signals to normal operation, a code goes to the control office which sounds the buzzer and extinguishes the detector indication lamp. Then the operator must restore the toggle switch lever to the up position.

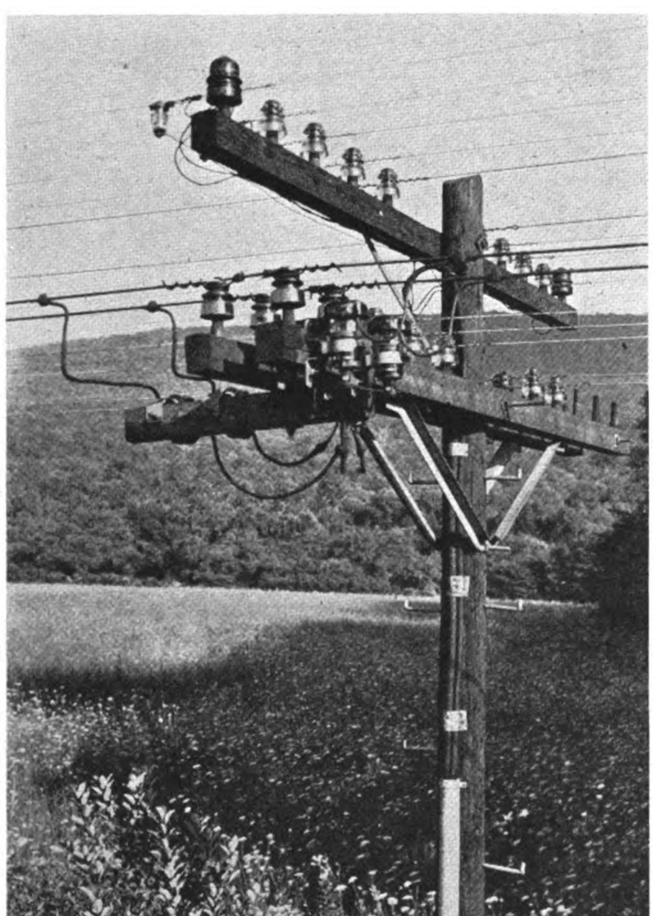
Control of Electric Locks

The electric locks on the hand-throw main-track switches are controlled by levers which are in the upper row with the switch levers. These lock levers normally are in the "locked" position which is on center.

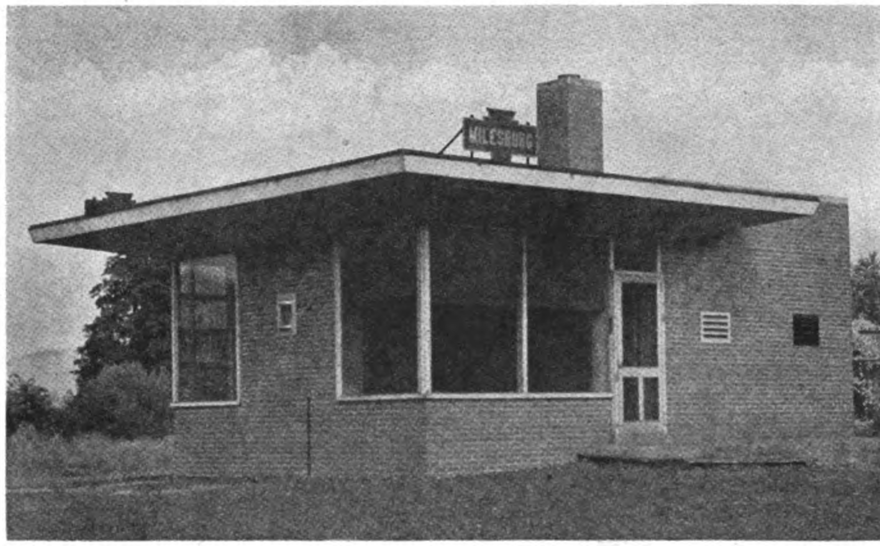
A short track circuit about 150 ft. long is located on the main track in approach to the facing points of each of these hand-throw switches, as shown in the sketch, Fig. 1, of the track between East Julian and Baker. When a train on the main track is to make a switching move into the spur, the locomotive or a car must be stopped on this 150-ft. track circuit. The conductor telephones the C.T.C. operator, requesting a release of the electric lock, and then the conductor unlocks the padlock and releases the foot pedal. This closes one of the contacts in the circuit. The operator turns the corresponding lock lever to the "In" position, which is to the left, and sends out a code to the field station at Baker which causes 100-cycle energy to be superimposed on the two C.T.C. line code wires going west to the switch location. By this use of superimposed energy, no extra line wires are required. At the switch location this 100-cycle energy is rectified to d.c. to pick up a relay. A circuit through the front contacts of this relay, a back contact of the relay for the 150-ft. track circuit, and the foot pedal contact, energize the lock coil.

To Leave a Spur

In some instances the local freight clears the main track when switching a spur. When ready to depart, the conductor telephones the C.T.C. operator to request a release. The operator throws the corresponding lock lever to the "OUT" position and sends a line code which goes to the field stations at Baker and at East Julian, where controls are set up to send track circuit code westward from Baker toward the hand-throw switch and eastward from East Julian toward the switch. If no train is occupying the intervening track circuits, the track circuit energy from the two directions picks up two relays at the



The pole-line work included only four wires, two for code line and two more for the 440-volt a.c.



The concrete canopy on this new C.T.C. office building is designed to allow the sun to shine in the windows during the winter but not in summer

switch. A circuit through the front contacts of these relays, a front contact of the relay for the 150-ft. track circuit and the foot-pedal contact, energizes the lock coil to release the lock so that the switch can be thrown. When the train is out on the main track and the switch is closed, the conductor telephones the C.T.C. operator to give him this information and tell him that he can now lock the switch. Then the operator returns the lock lever to center position and sends out a line code which releases the relay at the switch, thus restoring switch controls to normal.

A switch indication relay at the switch is energized when the switch is locked mechanically in the normal position, and the foot pedal held down by inserting the padlock, checking the switch locked normal, permitting display of signals in that block.

Instrument Houses

An insulated sheet-metal house 12 ft by 20 ft. with 8-ft. walls was installed at each power switch to house the relays, battery and other apparatus. Where ground is available, each house is located about 25 ft. from the track, thereby reducing chances of accidental damage. Each house is on a foundation and floor of reinforced concrete, and, at locations where floods have occurred in the past, the foundations were built to bring the floor level above high water. The entrance door leads to a room 5 ft. by 12 ft. which includes a telephone desk, and a stove, the purpose being to use this room not only as a telephone booth and as warming room for trackmen assigned to clean the switch during snow storms, but also as an office for an operator in case of extensive damage to the C.T.C. system by severe storms or flood. This room is cut off by a fireproof partition, and the door leading to the second room is kept closed and locked with a signal padlock.

Plug-in Relays

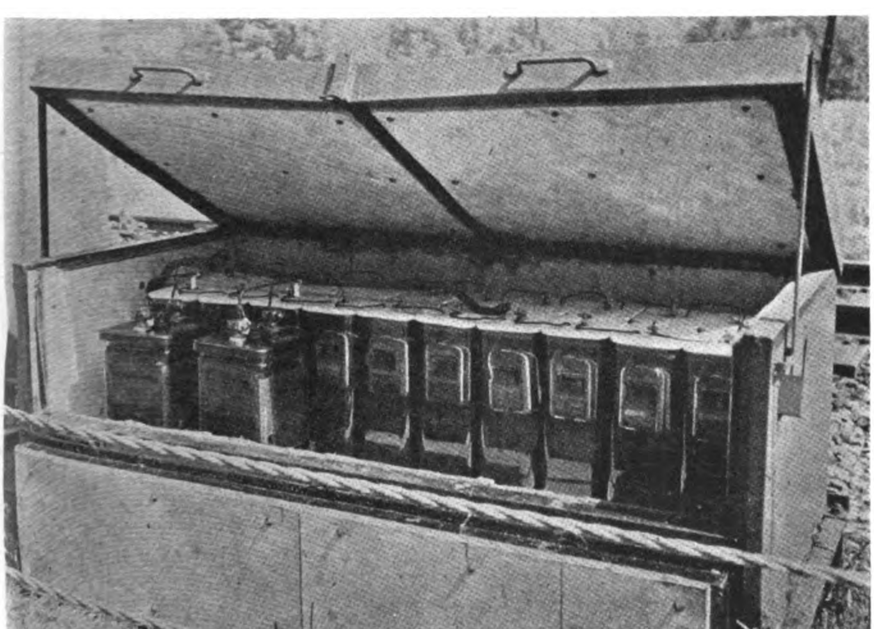
Based on apparatus available when this project was planned, certain relays are the plug-in type and the remainder are the conventional type but they are equipped with plug couplers and insulated nuts. The objective with respect to the use of plug-in relays and plug couplers is to expedite the replacement of relays when they fail, and at the same time to eliminate chances for wires to be connected improperly.

Special Type Racks

The plug-in type relays are mounted in racks constructed of angle iron with a capacity for 12 relays in each of five rows. The wires from the contacts in the receptacle plates extend to terminals on boards to the rear, and from these terminals wires extend to other racks or instruments. These boards are hinged at the bottom to swing down 90 deg. when making inspections. In order to prevent accidental contact with the terminal posts, a sheet of insulating material is placed over each board.

The conventional type relays with plug couplers are placed on shelves in a rack constructed with sheet-metal shelves, ½-in. asbestos back boards and 1½-in. by 1½-in. by ⅛-in. angle iron frame. The terminals are mounted on the front of the asbestos board at the rear, and the wires from these terminals extend through individual holes in the terminal board to run in insulated bridle rings behind. The wires coming into the house as well as those extending on to the apparatus are terminated on a ¾-in. asbestos board at the rear of the house. Also

(*Continued on page* 41)



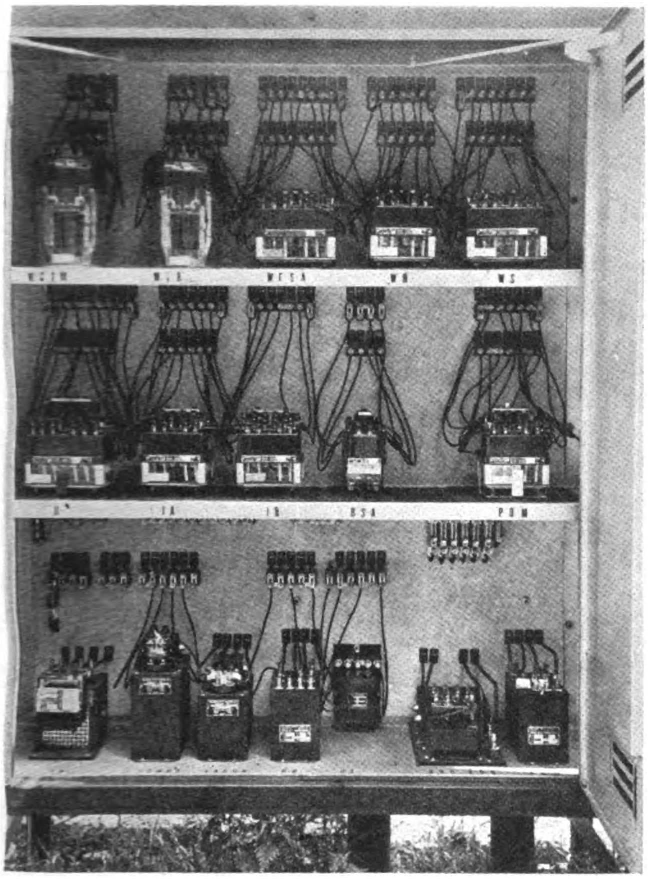
Storage battery and primary battery in insulated sheet-metal box at an intermediate automatic block signal

Pennsylvania C.T.C.

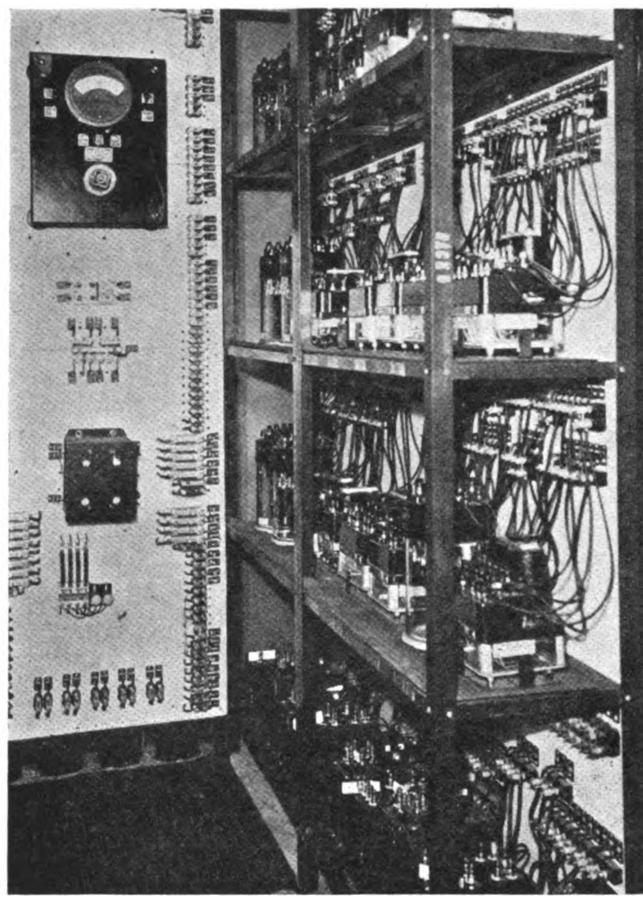
(*Continued from page 37*)

mounted on this board are certain resistance units, arresters, fuses, and a ground detector meter which can be switched to test for grounds on all batteries except track batteries at that location.

The underground cables coming into a house are brought in through transite pipes, 4 in. in diameter and curves on a radius of 48 in. so that the end above the floor is vertical and the other end, leading out through the wall under the ground line, is horizontal. The voids in this pipe are filled with sand, and the ends are sealed with mineral wool and asbestos cement.



The relays, transformers and rectifiers in sheet metal case at intermediate signal



A relay rack and a terminal board with the ground-detector meters

Pole Line Work and Power Supply

In this installation coded track circuits are used in a scheme which requires no line wires for the control of the automatic signals. A special arrangement including the use of 100-cycle energy superimposed on the C.T.C. code line is used for controlling electric locks on outlying hand-throw switches, thus requiring no extra line wires. Thus on this project there are only four line wires: the two No. 6 Copperweld bare wires for the C.T.C. code line, and the No. 4 copper weatherproof wires for the 440-volt a.c. power distribution circuit which feeds both directions from several locations, with gaps from the one feed to the beginning of the next, thus saving considerable wire. The two C.T.C. line wires are on the pole pins, and the two power wires are on the two end pins on the north end of the bottom arm.

At intermediate signal locations, at track cuts, and at electric locks, the a.c. energy feeds through transformers and rectifiers to provide the d.c. energy required for relays or lock coils. If the a.c. power fails, the d.c. energy required is taken from a 22-cell 1,000-a.h. primary battery. This battery is normally on open circuit, and in order to keep it active a ½-ohm shunt is placed across the battery to discharge it for 10 minutes, once a month. The signal lamps are fed from transformers normally. In case of an a.c. power failure at an intermediate signal, the lamps would be fed from the primary battery. Each track circuit is fed by a 240-a.h. lead type storage battery. At each power switch layout there is a 12-cell, 240-a.h. lead type battery which feeds the switch machine motor.

Insulated Battery Boxes

At the intermediate signals and electric lock locations the primary battery as well as the lead type storage battery on the track circuit are housed in large sheet-metal boxes which are constructed with a 2¾-in. layer of insulation in the walls, bottom and top. Mounted in the box is an electric strip heater rated at 75 watts for operation on 110 volts a.c. A thermostat regulates this heater to control the temperature between 35 and 40 deg. during the winter. These sheet-metal battery boxes are mounted on angle iron frames which are set so that the bottom of the case is a foot or more above the level of the ground, this space being needed to permit painting of the bottom of the case.

This C.T.C. installation was planned and constructed by forces of the Pennsylvania Railroad, the major items of apparatus being furnished by the Union Switch & Signal Company.