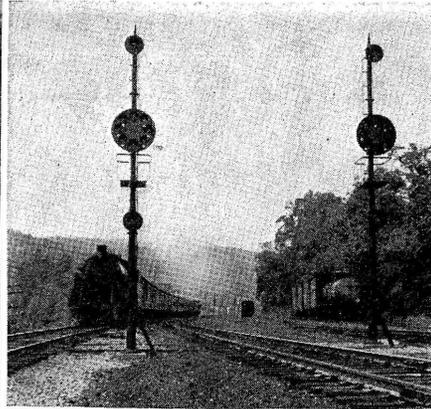
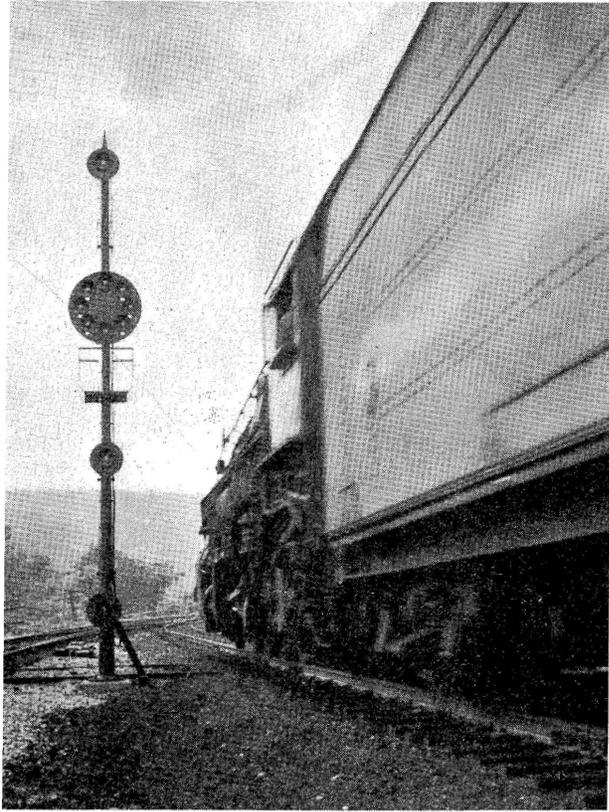


# A.P.B., Remote Control



Left—Westbound train leaving 2.2 mile double-track at Musselman. Right—Eastbound train at same location. Note train-order signals near base of mast.

THE BALTIMORE & OHIO has recently completed the installation of automatic block signals, replacing manual block signaling, on the Ohio division main line between Parkersburg, W. Va., and Midland City, Ohio, a distance of 150 miles, which completes the installation of automatic block system between New York and North Vernon, Ind. The installation of such signals between North Vernon and East St. Louis, Ill., will be finished by the end of this year, thus affording automatic signal protection over high-speed main lines between New York and St. Louis, Mo., and Chicago.

With this installation, 3 mechanical and 2 power interlockings were rehabilitated; flashing-light signals at 20 crossings were modernized, and the same type of protection replacing bells was provided at 6 other crossings; 1 direct wire and 1 code remote control interlockings were installed. In this territory, there are 140 miles of single track which embrace 28 single and 5 lap siding layouts, a total of 38 passing sidings; also 1 section of double track, 8 miles, and another 2 miles long, that are used to advantage in making train meets.

## Interlockings Rehabilitated

Mechanical interlockings were rehabilitated at Belpre, at the junction with the O. & L. K. branch; at Grosvenor, a crossing with the New York Central; and at West Junction, which protects one of the junctions with the

Toledo division and the end of double track.

Power plants rehabilitated were Dundas, at a crossing with the Chesapeake & Ohio, and Chillicothe, at a crossing with the Norfolk & Western.

## Two New Interlockings

New interlockings installed included one of the C.T.C. type for the protection of the east end of double track, and junction with the Toledo division at Byers Junction, the control point being at West Junction, and a second of a seven-lever table type located at Musselman, the west connection of a two-mile section where the Ohio division main line and a branch line of the Toledo division are in parallel. The latter layout consists of two switches and four signals at "RK," the east con-

nection, which is remote controlled, and two crossovers (four switches), and four high signals at Musselman. This two-track section, over which trains are operated by signal indication, in addition to handling traffic for the respective divisions, is also used for train meets and run-arounds.

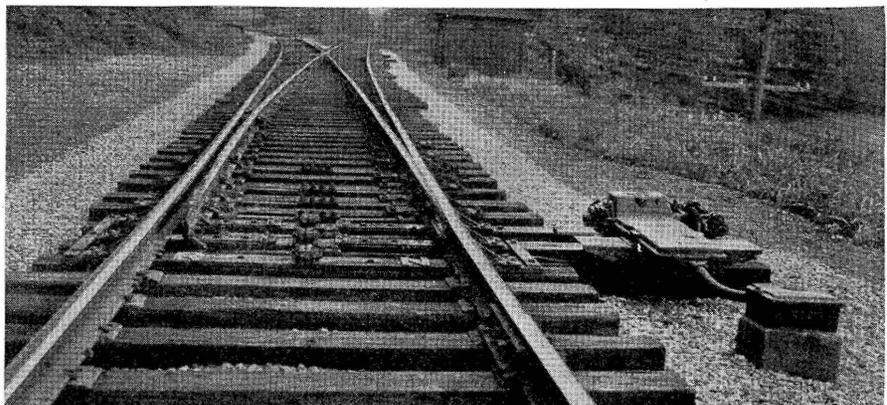
In the rehabilitation of crossing interlockings, main-track derails were removed.

Present traffic consists of 12 passenger and 6 regularly scheduled freight trains and several extra freight trains daily.

The purpose of the installation was to increase the safety factor and facilitate train movements.

## Signaling Features

Signals are of the Baltimore & Ohio's standard color-position-light type, and, as the name implies, pro-



One of the outlying Model 5-D switch layouts

# and C.T.C.

## on the Baltimore & Ohio

Four- and five-indication color position-light signals are installed on 150 mile single-track line between Midland City, Ohio, and Parkersburg, W.Va.—“RK” Junction is direct-wire controlled, while Byers Junction is operated by a three-wire coding system.

vide aspects that are readable either or both by color and position. The aspects and indications are as shown on the accompanying diagram.

This type of signal provides a number of features which, in comparison with signals of semaphore and other types, are worthy of note, among which are:

(1) Aspects and indications for high and dwarf signals are the same.

(2) Each aspect has an individual meaning and there are no duplications.

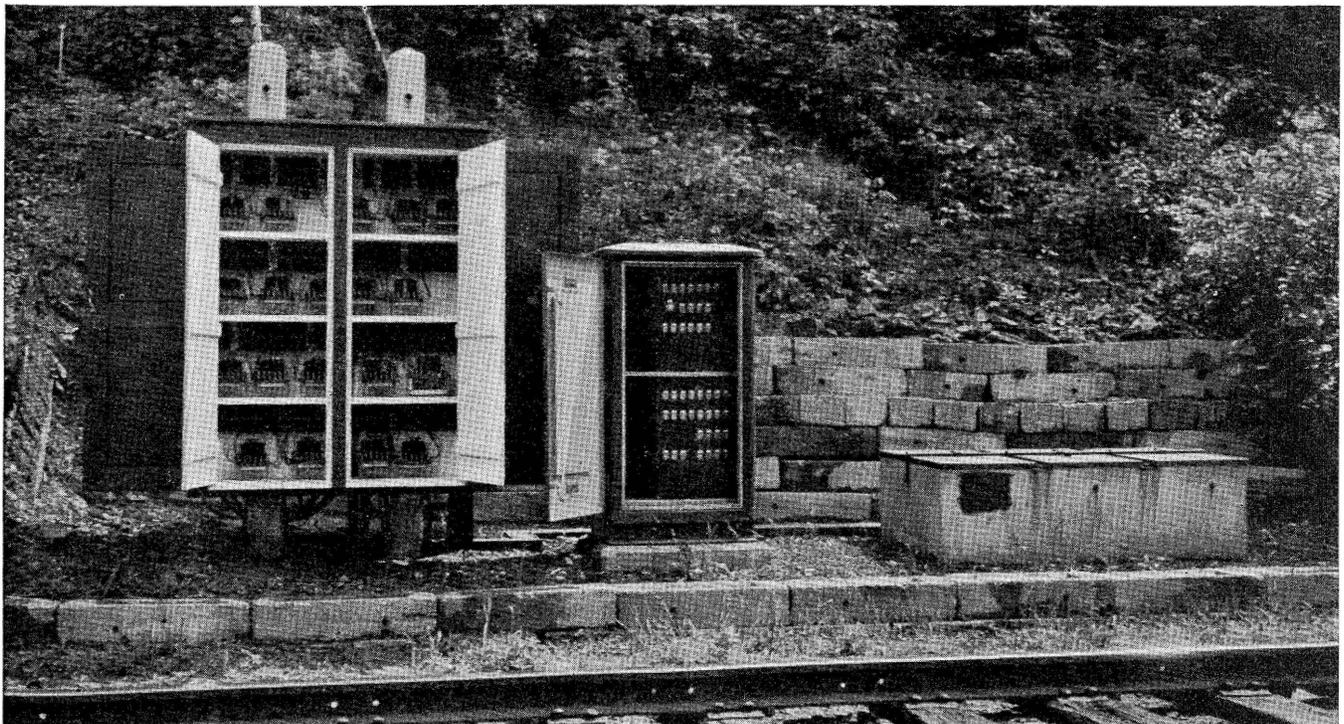
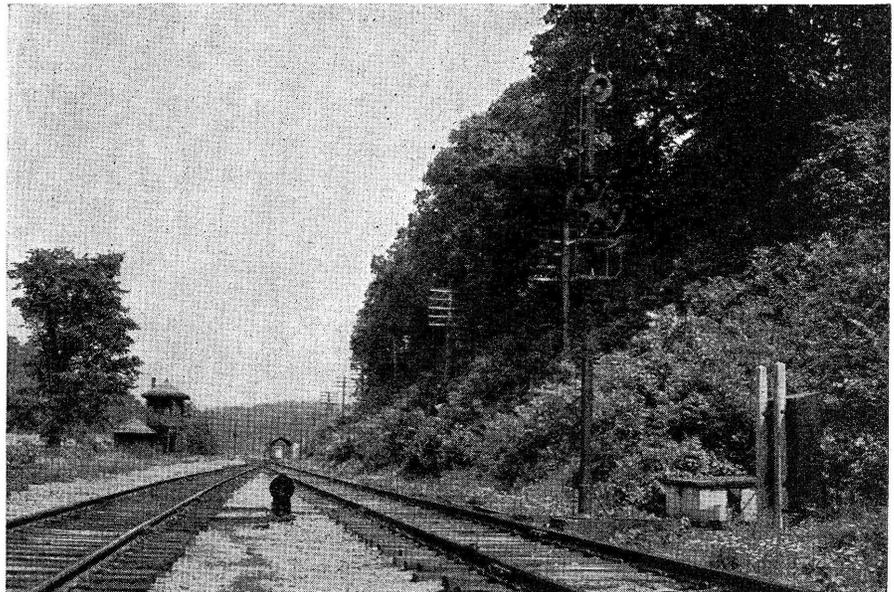
(3) All Standard Code Signal Rules of the Association of American Railroads are covered, and, in addition, there are a few others that are used to more clearly define both route and speed.

(4) Both “stop” and “stop and proceed” aspects may be displayed under different conditions on the same mast.

(5) No train is required to pass a signal on which the blocking lights are displayed horizontally or when red, without first coming to a stop—

except that a freight train of 80 per cent or more of its rated tonnage may pass a grade signal equipped with the letter “P” when indicating “stop and proceed” (Fig. 3), the rea-

son being, a train stopping on grade may have difficulty in starting, and furthermore the “stop and proceed”



Layout and instrument location at Byers Junction

Routes	Normal Route							
Day and Night Aspects								
Legend	R = Red Y = Yellow G = Green W = White LW = Lunar white							
Indication	Stop	Stop then proceed in accordance with rule 509(A) 509 (B), 509 (C)	Freight trains with 80 per cent or more of tonnage rating are not required to stop. Proceed in accordance with rule 509(A) 509(B), 509(C)	Block occupied. Proceed prepared to stop short of train ahead	Prepare to stop at next signal. Train exceeding medium speed must at once reduce to that speed.	Approach next signal at not exceeding slow speed	Approach next signal at not exceeding medium speed	Proceed
Name of Signal	Stop	Stop and proceed	Tonnage	Permissive	Approach	Approach slow	Approach medium	Clear

Aspects and indications used

aspect insures that the block is occupied by a preceding train.

(6) All indications are displayed by both position and color, each being a check against the other.

(7) The speed—whether normal, medium, or slow—at which a train may pass, is indicated with each display.

(8) Blocking lights—red, lunar white, yellow and green—are multiple connected, two in each circuit. The failure of a single light in either pair results in the loss of position but not of color, and trains are not required to stop unless the color is "red."

(9) The failure of a marker light results in the display of a more restrictive indication than that intended, namely: A stop or a slow-speed indication (Fig. 1, 16, 17 or 18). The train is governed by the indication displayed, and is not required to stop.

(10) Lights displayed in pairs and by position are arrestive, and there is no danger of confusion with switch, sign and other light along or near the right of way.

(11) Light failure relays are not required.

All signals in the 140 miles of single-track territory indicate in not less than 4 positions and provide not less than 2 approach and 1 stop indication against opposing trains, 1 stop and proceed and 1 approach indication for following trains.

The approach signals to passing sidings, the length of which in cer-

tain instances is less than braking distance, are equipped with an additional aspect, this signal indicating, as conditions require, "stop," "stop and proceed," "approach," "approach medium" and "clear." Approach medium is displayed when the second block ahead is occupied by a preceding train.

### Absolute Permissive Block

The absolute permissive system of wiring with provisional siding overlap was used. A train entering a block at an intermediate switch or crossover causes the display of stop indications at both ends of the block and directional control is not set up until the train passes out of that block. Provisional overlaps within the confines of passing sidings prevent simultaneous acceptance by opposing trains that are about to enter the long single-track sections between passing sidings. A train entering or leaving a passing siding does not prevent the display of an approach indication to another train to occupy the main track within the confines of the siding. A train, after leaving the confines of a siding, does not prevent the display of an approach indication to another train to occupy the main track within the confines of the siding. Under this system Standard Code Rule 509 (B) is modified to the extent that any train stopped by a "stop and proceed" signal—whether interlocked home or automatic—may, if its traf-

fic rights permit, proceed at once at slow speed, expecting to find a preceding train in block, broken rail or other obstruction, the same as in double-track territory.

The average block length is approximately 2 miles, while the maximum permissible speed of trains is 60 m.p.h. Except for the 7½ miles of double track east of West Junction, which is equipped with d-c. polarized track circuits, the approach and clear indications of the signals are line controlled over Type K, 1,000-ohm polar relays, with d-c. track circuits. The line circuits are operated at approximately 13.5 volts, with 6 EMGS-5 storage cells on floating charge from BX116 copper oxide rectifiers. All signal and line relays are 1,000-ohm GRS Type K, except for the slow-release relays, which are 500 ohms.

### Signal Control Circuits

Signal control line circuits of No. 10 A.W.G. double-braided, weather-proof, 30 per cent conductivity, copper covered, steel wire, supported on glass insulators on the lower cross arm, are direct fed from a 6-cell series connected trickle-charged, 80 a.h. storage battery. Line circuits are double controlled, i.e., both sides of each circuit are broken by the controlling apparatus to insure against false energization due to crossed or grounded circuits.

The 13½-volt, 17-watt signal lamps are approach lighted normally

Medium Route							Slow Route			
9	10	11	12	13	14	15	16	17	18	19
Stop then proceed in accordance with rule 509 (A), 509 (B), 509 (C)	Freight trains with 80 per cent or more of tonnage rating are not required to stop. Proceed in accordance with Rule 509 (A), 509 (B), 509 (C)	Block occupied. Proceed prepared to stop short of train ahead	Proceed at not exceeding medium speed. Prepared to stop at next signal.	Approach next signal at not exceeding slow speed	Approach next signal at not exceeding medium speed	Proceed at not exceeding medium speed.	Proceed at restricted speed.	Proceed at not exceeding slow speed. Prepare to stop at next signal	Proceed at not exceeding slow speed	Take siding
Stop and proceed	Tonnage	Medium permissive	Medium approach	Medium approach slow	Medium approach medium	Clear medium	Restricting	Slow approach	Clear slow	Take siding indicator

with Baltimore & Ohio signals

from a-c., and, in case of power interruption, from d-c. Power transfer relays of d-c. type are energized from rectified a-c. current.

Signal lighting circuits are carried in trench-lay cable from relay housings on the pole line side to a junction box supported at the center of the lighting cluster, which is located generally 17 ft. above the base of the rail. Cables are secured to the outside of the masts.

Shunt connections rather than line breaks are used as far as practicable under the general circuit scheme to protect against open or improperly adjusted switches. Two switch circuit controllers, with separate wiring and rail connections, are applied to facing switches; one only to trailing switches.

Switch fouling circuits at passing siding inlets are series connected and have 2-ohm fixed resistances at the battery end and an adjustable resistance at the relay end of each circuit.

For terminating wires in relay racks, housings and other points, A.A.R. binding posts, mounted on ebony-asbestos or wood, are used.

**Track Circuits**

Track circuits on this installation are double-rail, d-c., end-fed, neutral, except as noted above. Each track circuit feed includes a Type EMGS-7 storage cell on floating charge from a BX116 copper-oxide rectifier. The track relays are Type K rated at 2

ohms. O.-B. and A.S. & W. gas weld bonds were used for track bonding. The track leads consist of No. 9 A.W.G. rubber-covered and braided copper wire placed in trunking. Two connections are made to each rail by the use of two bond wires. These are doubled, soldered to the No. 9 track lead in the trunking, and brought up on each side of the rail, plug connections being made to the rail.

**Power Supply**

Commercial power for operation of the system, purchased at the various towns along the right of way, is carried through No. 4 A.W.G., double-braided, weatherproof copper conductors, supported on white porcelain insulators at the north end of the lower crossarm on Western Union Company's poles. These circuits carry 460 volts, 60 cycle, approximately 1,600 watts, average from 10 to 12 miles in length, and are arranged so that they can be fed from either end. Air-cooled, pole-mounted transformers are used to reduce the voltage to 115 volts. The latter circuit is carried into relay housings and again reduced to the proper voltage for charging either one cell of track or six cells of line, lead acid storage battery from copper oxide or Fansteel rectifiers, the latter being used for charging batteries required for the operation of flashing-light signals.

Lightning arresters for low-voltage circuits are of Neon gas triple-

path type manufactured by the Western Railroad Supply Company. Arresters for the 460-volt power circuit are General Electric Company's catalog No. 2906823 G2. Ground rods are 3/4 in. by 15 ft. copper-covered steel.

**Housings**

The instrument cases, which are mounted on concrete poles, are made of cypress and are of various sizes, 6, 9, 12 and 24-relay capacity cases being used as required. Double doors are provided on each instrument case, one behind the other, to protect against bad weather conditions. The lead-ins to the instrument cases consist of No. 14 and No. 9 A.W.G. rubber-covered wires made into cable form, with marlin ties. The cable is run on messenger to the concrete cable pole supporting the instrument cases, down the concrete pole and into the bottom of the instrument case, where it is terminated on the lower shelf. Jumpers, consisting of 19-strand No. 16 A.W.G. rubber-covered wire, are used to distribute the circuits inside the case. The relays are shelf-mounted. The rectifiers are mounted on the instrument case panels. Ebony terminal boards, drilled to take brass terminal bolts, were used for all terminal connections.

Concrete battery boxes, of any one of three different capacities, are provided at the different locations. These boxes were designed by the B. & O. signal department and are

built in sections. A single section box is used for track battery locations, while two or three section sizes are used for signal operating batteries. The battery boxes are placed on top of the ground and are provided with sheet-steel covers which fit down over the edges of the boxes. Connections between the instrument cases and battery boxes are run in No. 9 A.W.G rubber-covered wire placed in trunking.

### The C. T. C. Installation

The 7.5-mile stretch of double track extends from West Junction to Byers Junction, 14.5 and 22 miles east of Chillicothe, respectively. Prior to the installation of the automatic signals, the facilities at West Junction "BK" were controlled by a 32-lever mechanical interlocking machine on the second floor of the two-story tower with pipe-connected switches, pipe-connected upper-quadrant semaphore signals, electric locking circuits and two U.S. & S. Co. Style T, top-of-the-mast type power-operated distant signals, one on each main-track approach. Under the recent program, the track layout was revised, and the mechanical machine was retained in service, with the switches of the new layout pipe-connected, but the semaphore signals were retired, being re-

placed by color-position-light signals, are controlled and indicated by two stations, consisting of one field stepper unit and two storage units. These units also indicate the track occupancy of the five track sections mentioned previously. The apparatus for the field circuits at Byers Junction is housed in a wood instrument case similar to those used in the automatic territory while the field stepper and storage units are housed in a single cast-iron instrument case, mounted on a concrete foundation. A battery box at this location houses the 24-volt field battery, consisting of 12 EMGS-9 cells. The installation was placed in service on January 19, 1937.

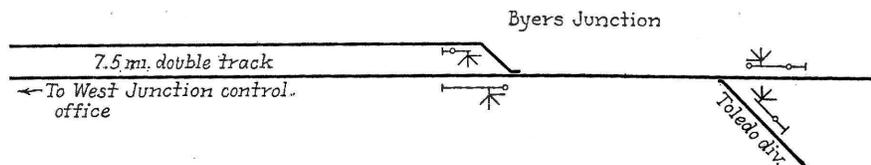
chines and three high and one dwarf color-position-light signals, are controlled and indicated by two stations, consisting of one field stepper unit and two storage units. These units also indicate the track occupancy of the five track sections mentioned previously. The apparatus for the field circuits at Byers Junction is housed in a wood instrument case similar to those used in the automatic territory while the field stepper and storage units are housed in a single cast-iron instrument case, mounted on a concrete foundation. A battery box at this location houses the 24-volt field battery, consisting of 12 EMGS-9 cells. The installation was placed in service on January 19, 1937.

As indicated in the accompanying diagram, the new track layout at "RK" Junction is similar to that at Byers Junction. With the exception of a turnout, the layout at Musselman is similar to that at West Junction. However, since "RK" Junction is only 2.2 miles east of Musselman, it was decided to use direct-wire remote control in this area.

### Direct-Wire Remote Control

At "RK" Junction the Ohio division main line between Cincinnati and Parkersburg crosses the Toledo division, extending between Portsmouth and Dayton. Previously the crossing involved a movable point frog layout, four pipe-connected upper-quadrant semaphore home signals and two wire-connected Ohio division distant signals, operated by a Style A mechanical interlocking machine located at "RK" Junction. This plant was dismantled, the movable point frog was replaced by two single switches operated by Model 5D switch machines, the pipe-connected signals were retired and replaced by color-position-light units, a new one-story cabin was built at Musselman, 2.2 miles to the west, and the "RK" Junction layout was direct-wire controlled from a table interlocker at Musselman over a 19-conductor aerial cable. The instruments at "RK" are housed in two double-door instrument cases located midway between the two turnouts, the local battery being 12 EMGS-9 cells on floating charge from two Fansteel full-wave C-10 rectifiers.

The layout at Musselman previously consisted of several passing and storage tracks with hand-operated switches. With the installation of remote control to "RK" Junction, the track layout was changed to involve two crossovers protected by four new high color-position light signals controlled from the table interlocker in



Type M, Style F, duplex centralized traffic control is used to control this layout

placed by color-position-light signals controlled over the tail levers. The tower instruments for BK interlocking were placed in a sheet-steel case on the second floor. Transite backboards were used in this case. Wood instrument cases, with double doors, were provided at the home signal locations. Six cells of EMGS-5 battery on floating charge on the first floor of the tower, and in concrete battery boxes at each home signal location, provide power. Aerial cable is used between the tower and home signal locations, the cables being taken into the back of the tower downstairs into a sheet-steel terminal box in the battery room. Jumpers from the cable terminals to the instruments on the second floor are 19-strand No. 16 flexible wires placed in 3-in. conduit.

In addition to these local changes at West Junction, it was decided to control the eastern end of the double track and a Toledo division turnout

The line wires to the Byers Junction end of double track are three No. 8 weatherproof copper line wires on glass insulators.

### Changes at Byers Junction

Prior to the installation of coded remote control, the layout at Byers Junction consisted of a spring switch at the end of double track, a hand-thrown crossover within the double track section, and a hand-thrown switch on the turnout for the Toledo division. The signals were controlled automatically according to the switch line-up. A manual-block office was located at Byers Junction with operators on duty two tricks.

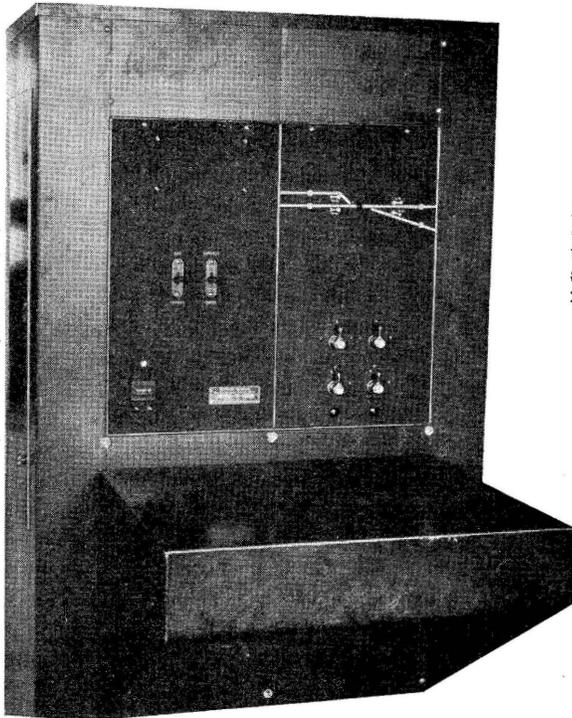
The remotely controlled revised layout which was installed at Byers Junction, eliminating the block office, is shown in the accompanying sketch. A total of two turnouts, equipped with G.R.S. Model 5D switch ma-

the new cabin. The table interlocker has seven levers, three signal levers and four switch levers. Lever No. 1 controls the four signals at "RK" while levers No. 2 and 3 control the two switches at "RK." Levers No. 4 and 5 control the crossovers at Musselman, while levers No. 6 and 7 con-

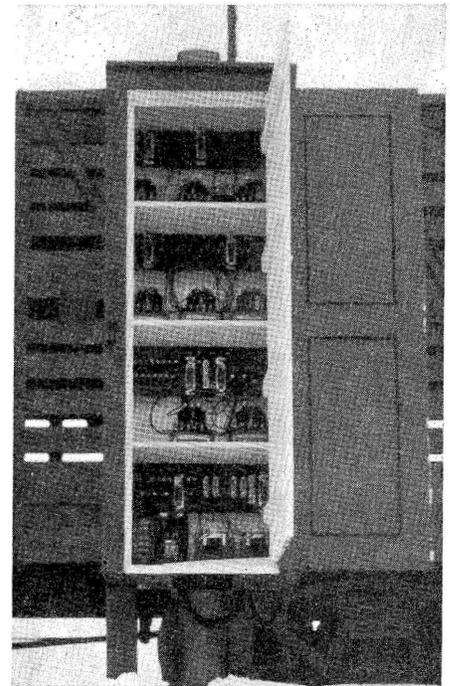
controlled (at "RK") is in transit, and with a red lamp to the left above the white lamp, indicating occupancy of the following section at "RK." A red lamp above and to the left of levers No. 2 and 3 is illuminated when a train on the approach to "RK" has made the time locking effec-

signals are controlled by knife switches in the cabin and give flashing red indications, their controls being broken through the contacts of a G.R.S. Model-9 flasher relay.

The cabin apparatus at Musselman is located in a sheet-iron case in a small room at the west end of the



Left—C.T.C. machine located at West Junction tower. Right—Small instrument case in automatic territory, freight car in background.



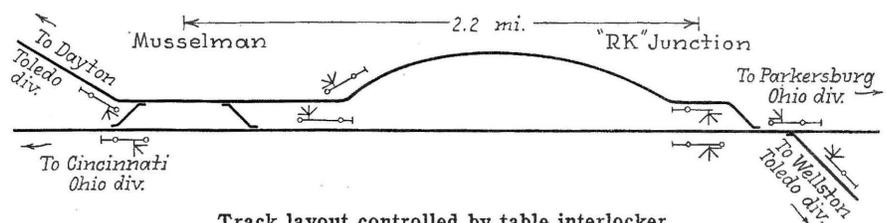
trol the westbound and eastbound Musselman home signals, respectively. The table interlocker is mounted on strap-iron brackets bolted to the concrete floor of the cabin.

### Indications

The indications provided in the face of each lever unit form one of the interesting features of this installation. On the face of the unit housing lever No. 1, a red lamp above and to the right of the lever indicates track occupancy on the westbound Ohio division "long" approach, when the train is approximately  $6\frac{1}{2}$  miles from "RK." A red lamp above and to the left of lever No. 1 acts as a second or "short" approach indication, showing track occupancy on the westbound Ohio division approach when the train is  $3\frac{1}{4}$  miles from "RK." A white lamp directly over lever No. 1 indicates when a signal controlled is cleared. Another white lamp directly above this one indicates track occupancy on the Toledo division westbound approach. The same indications are given for the Musselman layout for lever No. 7, and, with the exception of the "long" approach indication, for lever No. 6. Levers No. 2 and 3 are each provided with a white lamp above and to the left which indicates the switch

tive and means that, if a signal is to be taken away or a route changed at "RK," the signal lever must first be placed normal, placing a  $4\frac{1}{2}$ -min. time-element relay at "RK" in operation. At the expiration of this time, the switches may be moved. Levers No. 4 and 5, controlling crossovers at Musselman, are equipped with similar indications. However, the time locking at Musselman is obtained by using a Union clockwork time release with intermediate contacts, 4-min.

cabin. Access to the back of this case is provided by two large panels which may be released and slipped out. Sheet asbestos was placed on the sheet-steel shelves, and transite back-boards were provided. Three instrument locations are provided in addition to the cabin, one in the center for the switches, and one at each home signal location. Two 30-conductor parkway cables carry the circuits from the pole line to the cabin, entering a sheet-steel terminal box, mounted on the west wall of the



Track layout controlled by table interlocker.

time delay being provided for westbound trains and 5-min. for eastbound trains.

### Unusual Train Order Signals

The train order signals at Musselman are also of unusual design. A red marker light unit is mounted approximately  $2\frac{1}{2}$  ft. above the base of each of the westbound home signals. These

cabin, from the bottom. A 3-in. conduit is run from the top of the terminal box to the sheet-steel instrument case and houses 19-strand No. 16 AWG jumpers which are fanned out in the back of the case and taken through  $\frac{1}{4}$  in. holes in the transite back board, through holes in red fibre tags tacked on with brass pins, directly to the relay terminals. The battery for the plant is housed in concrete bat-

tery boxes at the switch location and consists of 12 EMGS-9 cells on floating charge from two Fansteel full-wave C-10 rectifiers.

### Circuit Protection

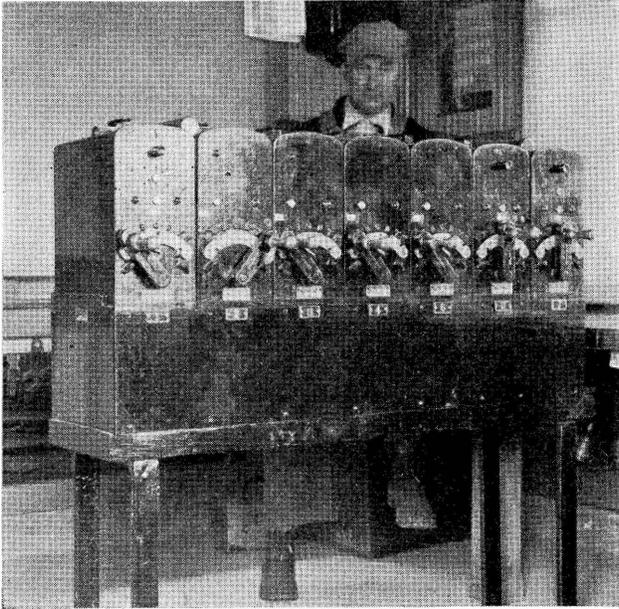
Wires at interlockings between the tower and home signals are carried in aerial braided cables on Western Union Company's poles. As a pro-

bridge and building department of the railroad, placed collapsible forms, mixed and poured the concrete foundations at each location, and removed the forms, moving on from section to section. The Western Union Company provided three gangs of approximately 12 men each, to rearrange the pole line. One gang specialized in crossarming and guying, while the other two gangs specialized in string-

gangs consisting of approximately 15 men each. These gangs ran the track leads, did all the bonding, made up the cable lead-ins and placed and wired all the instruments. The foremen, general foremen, and signal inspector supervised the testing.

### Material

Material salvaged by the respacing of signals on other divisions, and the removal of material from branch lines, was the first to be used. Signals, relays, transformers, rectifiers, resistances, switch circuit controllers, interlocking and centralized traffic control machines, and other accessories, were furnished by the General Railway Signal Company; flashing-light signal materials by the Western Railroad Supply Company; storage battery by the Electric Storage Battery Company; line wire and cable principally by the General Cable, Anaconda and Copperweld Steel companies; bond wires of gas-weld type by the American Steel & Wire and Ohio Brass companies; glass insulators by the Graybar Electric Company; and porcelain insulators by the Locke Insulator Company. Concrete battery housings, relay and cable posts, relay boxes and racks, storage battery



Left—Table interlocker controlling facilities at Musselman and RK Junction

Below — Eastward signals at Musselman. Note two markers above main units

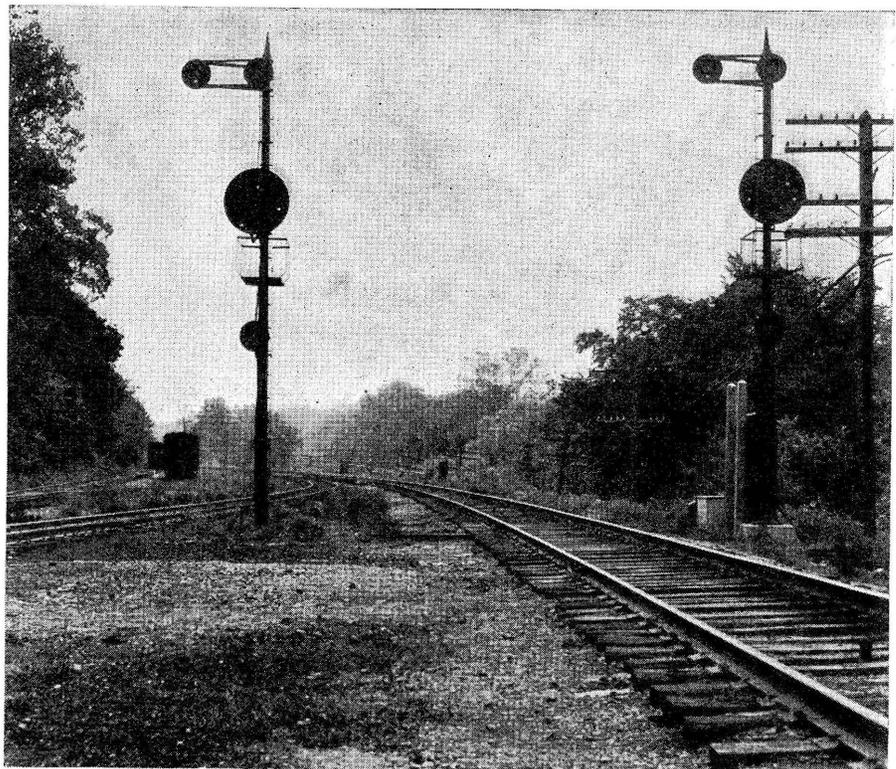
tection to coil windings and also to lessen the fire hazard where apparatus is housed in towers or other buildings, entering circuits are carried to an enclosed metal case which houses the arresters. Wire used inside of buildings has a flame retarding finish and special effort is made to insure against fire occurring either from lightning or crossed circuits. While flame-proof wire is used for making relay jumpers used in exterior relay housings, no additional protection against fire is provided at such locations.

The Musselman layout and the remote control of "RK" Junction was placed in service on May 4, 1937.

### Construction Methods

The signaling system for this territory was designed in the office of G. H. Dryden, signal engineer at Baltimore, Md. The installation was made under the direction of E. T. Ambach, assistant signal engineer, by W. N. Davidson, C. K. Fields, and F. M. Kunker, general foremen of signals. G. H. Cannon was the signal inspector on this installation.

Work on the installation was started on August 15, 1936. Two gangs, each gang consisting of 10 men of the



ing wire and tying in. The relays and signal instruments were shipped to the nearest point and then taken out to location and installed by eight signal

shelving and all reclaimed material used, was manufactured new or overhauled at the Zanesville shops of the Baltimore & Ohio.