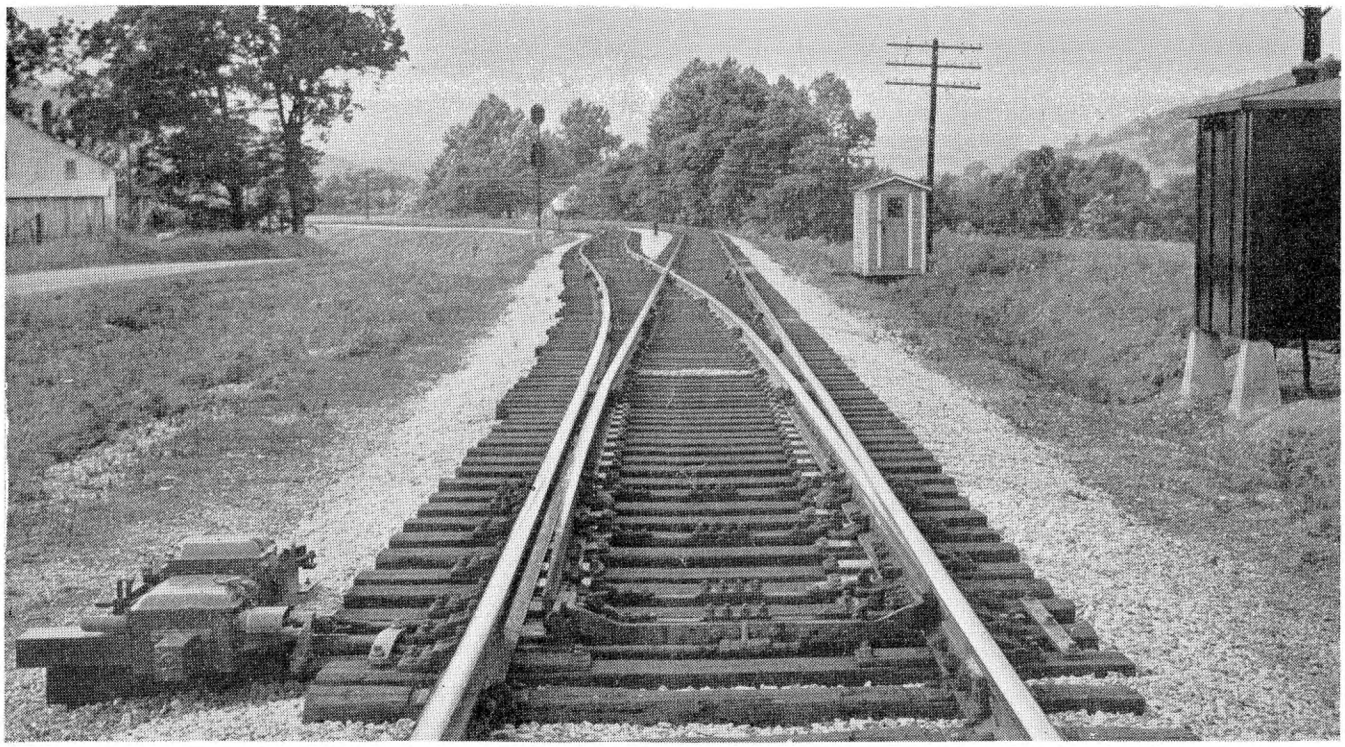


Typical power switch layout on centralized traffic control territory

C.T.C. Increases Capacity Freight Line Handling

Coal traffic, as well as manifest, is expedited on Big Sandy River Line in Eastern Kentucky Mountains

As a means of increasing track capacity and improving the safety of train operation, the Chesapeake and Ohio has installed modern signaling on the Ashland Division between Big Sandy Junction, Ky., and Elkhorn City, Ky., 128.2 mi. This includes centralized traffic control on 59.3 mi. of single track and 12.4 road miles of double track between Big Sandy Junction and Martin, Ky., and automatic block signaling on 42.7 mi. of single track and 1.7 road miles of double track between Beaver Junction and Elkhorn City, Ky.

At Big Sandy Junction, which is the west end of this project, the Big Sandy Subdivision connects with the east-and-west main route of the Chesapeake and Ohio between Newport News, Va., and Cincinnati, Ohio. Big Sandy Junction is on the south bank of the Ohio river, and from there the Big Sandy Subdivision, on which the new signaling was installed, follows up the valley of the Big Sandy river and its branches for 128.2 mi. eastward to Elkhorn City, Ky. Accordingly, the line ascends eastward at a river grade except for short rolling grades where

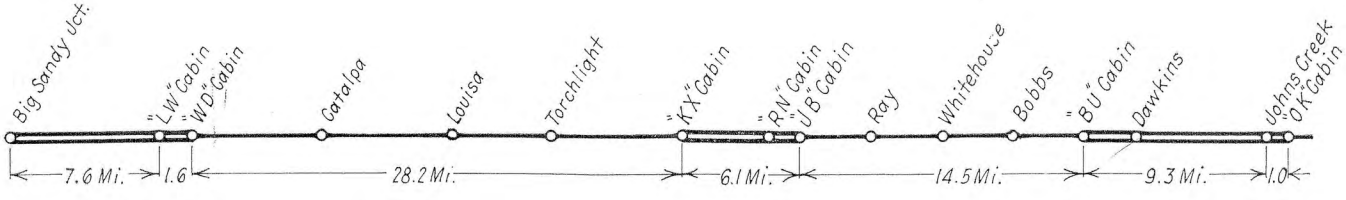
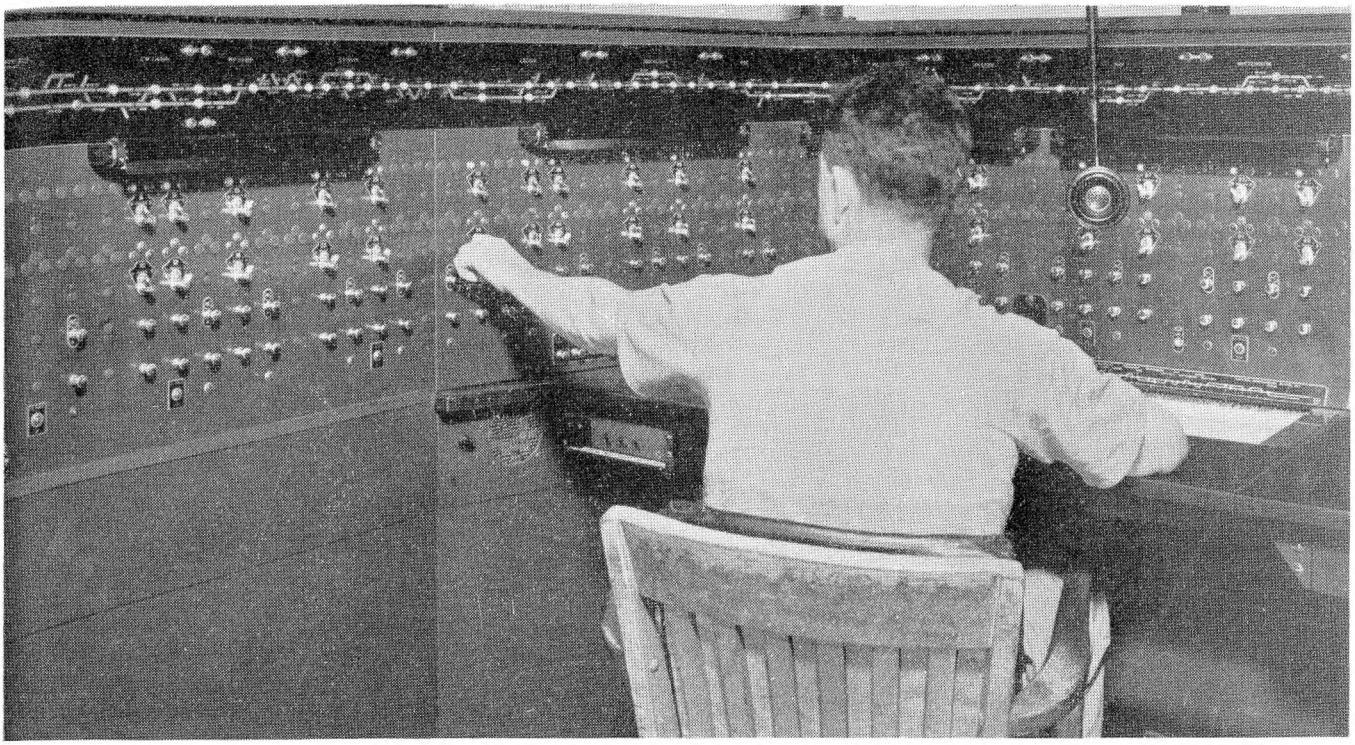


Fig. 1—Diagram indicating the field locations and sections of single or double



The C.T.C. control machine is in the dispatcher's office at Ashland, Ky.

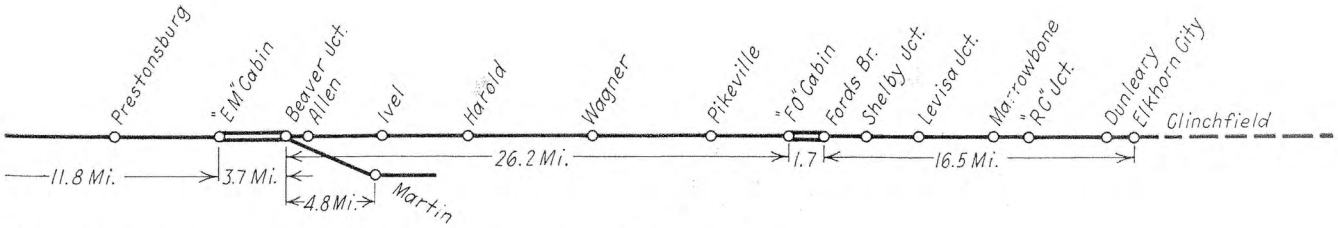
# of Single-Track Heavy Traffic

it is located across bottom lands a short distance from the river. The elevation above sea level is 559.3 ft. at Big Sandy Junction and 797.8 ft. at Elkhorn City. Throughout the last 100 mi., the railroad is in a narrow valley between rugged hills, and Elkhorn City is at the base of the main ridge of the Pine Mountains.

At many locations, the valley is narrow with the river on one side of the track and a steep hillside on the other side. Therefore, from an economical standpoint, the sidings and sections of second main track could only be constructed at certain locations where open space was available. Double track extends 7.6 mi. east from Big Sandy Junction to LW Cabin where there is a pair of main track crossovers. From here the two main tracks extend 1.6 mi. to the end of double track at WD Cabin, each main track being signaled for either-direction operation. Single track extends 28.2 mi. between WD Cabin and KX Cabin, with sidings at Catalpa, Louisa, and Torchlight. Two main tracks, each signaled for either-direction operation, extend 6.1 mi. between KX Cabin and JB Cabin, with a pair of main track crossovers at RN Cabin, then single track 14.5 mi. from JB Cabin to BU Cabin. Double track, right-hand running extends 9.3 mi. to a pair of main track crossovers at Johns Creek, and from this point the two main tracks extend 1.0 mi. to the end of double track at OX Cabin, each main track being signaled for either-direction operation. From OX Cabin to EM Cabin, 11.8 mi., is single track with a siding at Prestonsburg. From EM Cabin to Beaver Junction, 3.7 mi., there are two main tracks, each signaled for either-direction.

Location of Controls

The switches and signals at Big Sandy Junction and at Beaver Junction are included in interlockings which are controlled locally. The power switches at the ends of sid-



track on the entire territory between Big Sandy Junction and Elkhorn City

ings, at the ends of two-track section, and at crossovers between main tracks between LW Cabin and EM Cabin, inclusive, as well as signals governing movements over these switches and crossovers are controlled by a centralized traffic control machine in the dispatcher's office at Ashland, Ky. The signals on the branch line between Beaver Junction and Martin, 4.8 mi., are controlled jointly by the operator at Beaver Junction and the operator at Martin. Straight automatic block signaling was installed between Beaver Junction and Elkhorn City, with the exception that at Fords Branch there is a table lever control machine which contains signal and switch selection levers, controlling signals at Fords Branch and Shelby Junction, the switches and crossovers being hand operated.

Manifest And Coal Traffic

At Elkhorn City, the Chesapeake and Ohio connects with the Clinchfield, which extends southeast, connecting with other railroads serving North Carolina, South Carolina, eastern Georgia, and Florida. The C. & O. operates two manifest freight trains each way daily for interchange with the Clinchfield at Elkhorn City. This traffic varies depending on the Florida fruit and vegetable season, as well as other factors, but on the average the manifest trains each handle from 60 to 70 loaded cars in addition to empties.

Aside from the manifest freight interchanged with the Clinchfield, as well as that to and from stations on the line, the principal traffic on the Big Sandy Subdivision consists of westward outbound cars of coal and eastward inbound empty coal cars. There are a large number of coal mines located in the territory served by the Big Sandy Subdivision main line and branches, ranging in size from the small wagon mine that trucks its coal from the mine entrance to a nearby ramp, located adjacent to a spur track, where the coal is dumped into the waiting empty coal cars, to the large mine operation where the coal is hauled directly from the mine to a plant that cleans, washes, and grades the coal and conveys it to empty cars at the tipple served by spur tracks from the branch or main tracks of the railroad, there being 150 or more such loading points on the subdivision.

Mine-run local trains are operated to set out empty cars and to concentrate the loads in yards where tonnage trains are made up for operation through to Russell Yard which is on the east-and-west main line, 10.5 mi. west of Big Sandy Junction. When the mines are in full operation and cars are available, about 800 loaded cars are dispatched daily from Shelby Yard, 600 from Martin, and 200 from Paintsville. The total of 1,600 to 1,700 cars of coal daily is from 500 to 600 more than the daily maximum number handled in 1945 and 1946. Furthermore, an increase to 2,000 or more loaded cars daily is anticipated when mines now being opened up are in operation.

Ordinarily, the loaded coal cars are handled in solid trains, each consisting of about 120 cars, totaling about 9,600 tons, however, light tonnage trains, out of Martin, pick up at Paintsville. Approximately 12 loaded coal trains are operated westbound daily, and about the same number of trains of empty coal cars are operated eastbound.

The tonnage rating is 10,000 tons westbound. No tonnage rating is set up for eastward trains as they all handle empties and are limited to 160 cars. Because the railroad follows the river, the grade is descending all the way westbound, which is the direction in which the loaded cars are moved. The ascending grade eastbound is at river grade varying up to a maximum of 1.22 per cent. Curves are numerous but only a few are sharp enough to restrict the speed of freight trains. The maximum authorized speed of the manifest freight trains is 40 m.p.h. and coal trains 35. m.p.h.

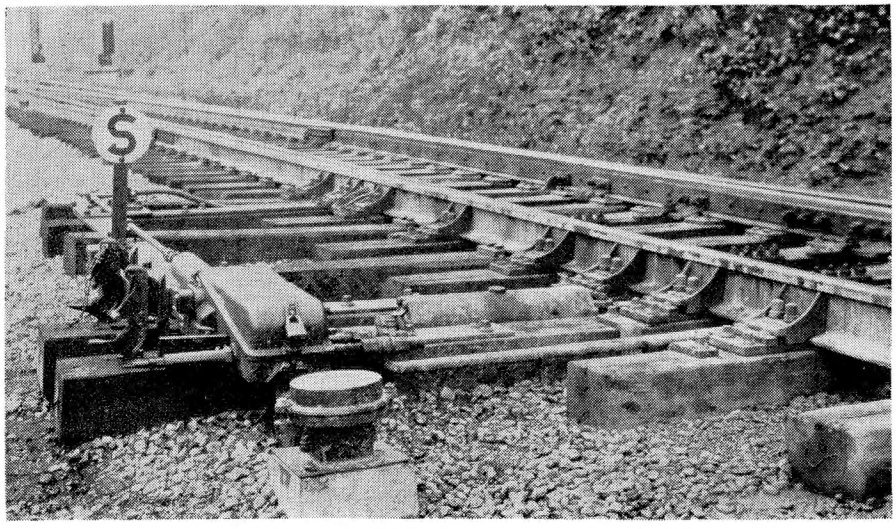
Two scheduled local passenger trains making all stops, are operated each way daily. These trains make connections at Ashland with main line trains east and west, and with Lexington Subdivision trains, and at Elkhorn City, with the Clinchfield.

No Signaling Before

Prior to the construction program being discussed, there was no automatic signaling on the Big Sandy Subdivision, the train movements were authorized by timetable, train orders and manual block. The block offices were from 6 to 7 mi. apart. It was the practice to maintain absolute block for passenger train movements while freight trains were permitted to follow one another in the same block with the following train receiving a permissive signal on entering the occupied block, requiring operation at restricted speed. Meets at blind sidings were not permitted. At times, trains had to wait to enter a block, and this delay frequently caused the passenger trains to lose much time. As traffic continued to increase, some means of increasing the track capacity by running trains closer together was necessary, and it was decided to install centralized traffic control with power switches and automatic block signals in the territory as previously indicated.

Some of the benefits that have been derived from this installation are the increased capacity of the territory on account of being able to run trains closer together with the safety of automatic signal protection. Dispatchers, by closely observing the location and progress of the trains on the territory, as indicated on the illuminated track model board, can plan and execute closer meets that save considerable time for trains in the C.T.C. territory.

When trains were operated by train orders and manual block it was not uncommon for a coal train, from Martin or Shelby to Russell, to have its crews relieved en route, however, with the installation of signals and



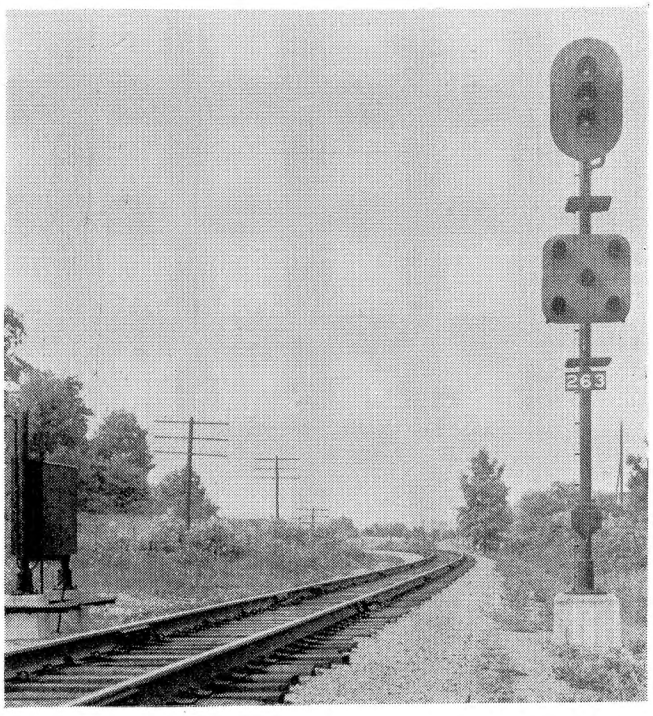
Spring switch at west end of siding at Wagner

C.T.C. the average run is made in from four to five hours as compared with eight or more hours previously.

Color-Light Signals

The signals on this project are of the color-light type, using double-filament lamps rated 18 plus 3.5 watts at 10 volts, however, where the approach to a signal is on a curve, requiring the use of spreadlite lens, double-filament lamps rated 30 plus 6 watts at 10 volts are used. The controlled signals in C.T.C. territory are continuously lighted and all others are approach lighted. At all signal locations where there are two color-light unit heads mounted on the same mast, a lightout relay is connected in series with the lamp filament of the lamps in the top unit with the control circuit for the lamps in the bottom unit cut over a contact of the lightout relay when energized, so that should a lamp filament in one of the lamps in the top unit burn out, it will deenergize the lightout relay, causing a stop indication to be given by the bottom unit of the signal, rather than a better indication that would have resulted had not the lightout relay been used.

The signals display standard A.A.R. Signal Section aspects, and in addition the C. & O. has a special aspect used on distant signals as advance information that an approaching train is to take siding. One of the accompanying pictures shows intermediate signal No. 263, which has a standard color-light signal head at the top of the mast, and also on the same mast there is a square background with five lamp units. These lamps are normally dark, but when a power siding switch is reversed for an approaching train to enter, the station-entering signal, such as Signal 40L at the east end of Louisa, will display red-over-yellow aspect, and on the signal in approach, No. 263, a yellow indication is displayed in the regular signal head, and all five of the lamps in the lower unit are lighted in the form of a figure "X." Thus, with these aspects, the engineman of a train can bring his train up to and through the turnout into the siding without being prepared to stop at the entering signal. This saves considerable time as compared with bringing the train up to the siding prepared to stop, as would be the case if nothing better than approach aspect were displayed on the distant signal when the switch is lined for a train to enter the siding. The dwarf signals for directing trains to depart from sidings are of the color-light type and display Stop, Slow Approach, and Slow-Clear indications. The Slow-Clear aspect informs the engineman that the next signal ahead is displaying either the Approach or Clear aspect and, therefore, as soon as his train has passed through the turnout to the main track, the engineman can accelerate the speed to normal.



Signal in approach to power siding has special lower unit used when switch is lined to enter

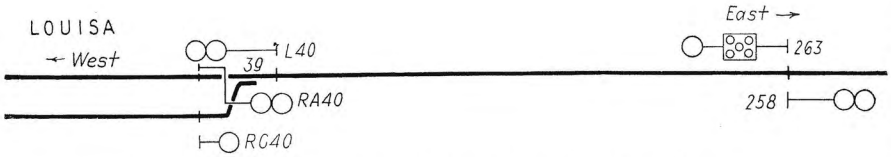


Fig. 2—Sketch showing special aspect on signals such as 263

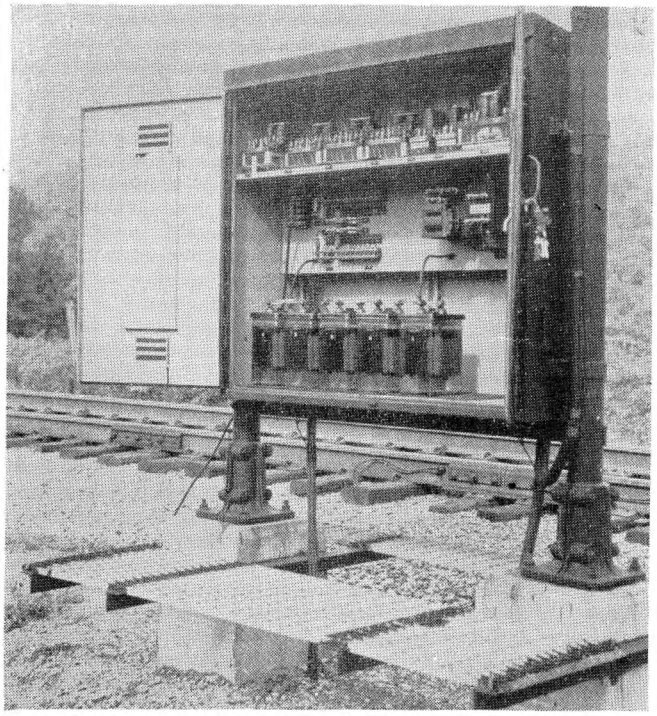
Power Switch Layouts

The power switches are operated by dual-control low-voltage d.c. electric switch machines, rated at 20 volts. Roller bearings were installed to make the switches operate easily. Each switch layout is equipped with adjustable rail braces on five, six, or seven ties, depending on the length of switch point. A special feature of the power switches on the Chesapeake and Ohio is the use of two coil springs on the operating rod, one on either side of the switch adjustment bracket. The purpose of the springs, one for normal and the other reverse operating, is to provide a cushion so that the mechanism can complete its full-stroke operation without producing excessive strain on the switch points, connecting rods or their connections, under slightly varying conditions of adjustment. The cross section of the spring is 5/16 in. by 5/16 square and is formed with 1¾ in. inside diameter. The nuts are adjusted to hold the spring within approximately one-fourth inch of being fully compressed so that if it should break, less than one-fourth inch slack would occur in the operating rod connection. None of the springs purchased under the present specification have broken, and many of them have been in service for several years.

Electric Locks on Hand Operated Switches

Some of the crossovers between main tracks and switches leading to branch lines and industry tracks are operated by hand. At these switches, however, the old stands were replaced with hand-operated switch-and-lock movements. In most cases a pipe connection from this mechanism extends to and operate a derail located at the clearance point on the turnout.

At each main track hand-operated single switch an electric lock was applied to the operating lever. At hand-operated crossovers, a pipe



Instrument and battery case at an intermediate signal showing the platforms

connection from the lock plungers of the two main track switches extends to a lever stand located between the rails at the center of the crossover, and an electric lock on this lever locks the lever normal.

At locations where a train is permitted to clear the main track, a dwarf signal governs the movement to the main track. The electric lock at such locations is controlled from a lever in the C.T.C. machine. At all other electric switch lock locations the electric locks are controlled automatically in conformity with A.A.R. Signal Section Requisites, Part 211, "Electric locks applied to hand-operated switches for the protection of main track movement."

The C.T.C. Control Machine

The machine which controls the centralized traffic control between Big Sandy Junction and Beaver Junction is in the dispatcher's office at Ashland, Ky., 6 mi. west of Big Sandy Junction. This control machine is made up of a 5-ft. panel in the center, with two 2.5-ft. panels set at angles on each side as shown in the accompanying picture. It has 30 levers to control 76 signals, 26 levers to control 20 power switches, and 6 power crossovers, and 6 levers to control locks on hand-operated switches and crossovers. Track occupancy of each section of main track, as well as passing siding, is indicated by a lamp in the corresponding section of the track model on the C.T.C. machine. The control machine is equipped with a 40-pen train graph. The pens are of the three-position type so that when the track circuit in which a power switch is located is occupied, with the switch normal the pen moves to the left, when the switch is reversed the pen moves to the right, thus indicating when a train takes siding or holds the main track.

The time code system, using two line wires, is employed for transmitting controls to the field stations and for returning the indications to the control machine. Conventional d.c. codes are used on the 49.5-mi. section between Ashland and JB Cabin. The wires in this section also handle outgoing carrier codes at 18 k.c. to JB Cabin where they are converted to d.c. code for control of the field stations between JB Cabin and Beaver Junction. The indications from the field stations between Beaver Junction and JB Cabin are converted at JB Cabin to 12 k.c. carrier codes to be transmitted to the office at Ashland. In all, there are 52 field stations, 24 between Ashland and JB Cabin, and 28 between JB Cabin and Beaver Junction.

In addition to the C.T.C. codes, these two line wires also handle a voice-frequency telephone service for use by signal department employees when making tests or when necessary to talk with the dispatcher and with each other. The maintainers, foremen, and supervisor all have telephones especially equipped for this service. If a maintainer wants to call the dispatcher on this circuit he pushes a button for several seconds which operates a buzzer, placing a tone on the line, causing an L-1 call-detector relay in the dispatcher's office to be energized. This sounds a special buzzer, and lights alight to indicate to the dispatcher that he is wanted on the code line. Special filter units are connected to the C.T.C. line in connection with this telephone circuit. Code-operated maintainer's call lights are provided at each instrument house to enable the dispatcher to communicate with a maintainer.

Automatic Block Signal Territory

In the automatic block signaled territory between Beaver Junction and Elkhorn City the signals at the ends of the siding are located the same as in C.T.C. territory. For example, Fig. 3 shows the signals at the east end of the siding at Harold. If an eastbound train on the siding at Harold is ready to depart, the head brakeman reverses the hand-operated switch stand. Contacts in the switch circuit controller cause leave-siding dwarf signal No. 934C to take over the line control circuits of high signal No. 934. In such a case, the rules require that the engineman must wait sufficient time to secure full benefit of signal protection before accepting the signal. This allows time for an approaching main line train to stop short of the main track signal at the end of the siding before the train on siding departs.

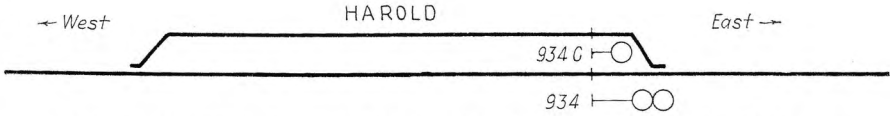


Fig. 3—Leave-siding signal at hand-throw switch in automatic block territory

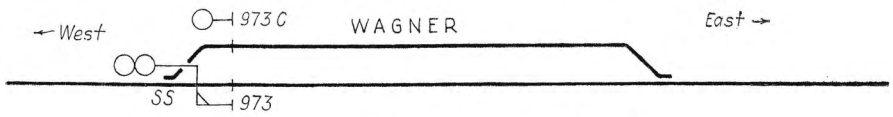


Fig. 4—Signals at spring switch layout

Spring switch mechanisms are in service at the ends of some of the sidings such as at the west end of Wagner, as shown in Fig. 4. At such a location the line controls are normally connected to cause leave-siding signal No. 973C to display Slow-Clear aspect, and main track leave station signal No. 973 is set to display the red aspect. When a westbound train on the main track enters the approach circuit to Signal No. 973, the line control circuits are changed to control dwarf signal No. 973C to the red aspect, and high signal No. 973 to the Clear aspect, if block conditions permit.

The automatic block signaling is controlled by conventional A.P.B. double-wire circuits, using d.c. neutral track circuits and double-break polar line control circuits. The polar line relays are retained neutral type which prevent a red flash when the aspect changes from yellow to green.

Instrument Houses

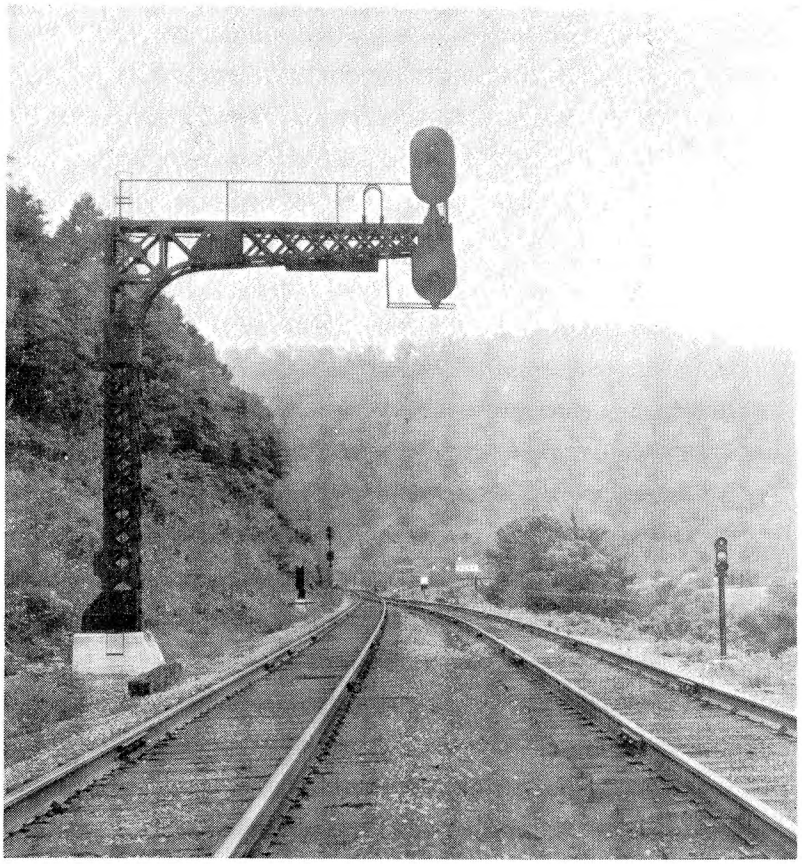
At the field stations, relays, rectifiers, coding equipment, and storage batteries are in sheet-metal houses set on concrete piers. At locations where the river may flood, the houses are located on piers above record flood level.

At intermediate signals, relays, rectifiers, and storage batteries are in sheet-metal cases. The wires and cables enter a wiring space at the rear of the panel which is made accessible by removing sheet-metal panels held in place by stud bolts. The case is supported at each end by a section of four-inch pipe mast in a cast-iron base on a concrete foundation. A platform of metal grating is provided at both the front and rear of the case so that a man can easily reach all the aparatus in a case.

Pole Line Modernized

New 10-pin arms were added to the existing pole line which was rebuilt. All defective poles were replaced, the new ones being Southern Pine creosoted full length. The poles are spaced approximately 150 ft. apart.

The C.T.C. code line consists of two No. 8 copper covered steel line wires, 40 per cent conductivity, while No. 10 copper covered steel line wire, 40 per cent conductivity, was used for all signal control circuits, and No. 6 copper line wire was used for the 440-volt power distribution circuit. All line wires have weatherproof covering. Air-cooled line transformers, rated 440/110 volt, mounted on the crossarm, range in size from 75-watt capacity at single signal locations to 150-watt capacity at double locations, and to 500-watt capacity at code station locations.



Signals at the spring switch at the west end of Wagner siding

Power Switch Batteries

At each power switch location there is a set of 13 cells of 110-a.h. lead storage battery to operate the switch machine. Eight of these cells are also used for code operation. Five cells of 240-a.h. lead storage battery are used for signal circuits, and act as a stand-by to feed the signal lamps should the a.c. power fail. At each intermediate signal location there is a set of five cells of 150-a.h. lead storage battery to feed the line and serve as a stand-by for the lamps. In the control office the code line is fed by a set of 42 cells of 15-a.h. lead storage battery, and there are two sets of 8 cells of 240-a.h. lead storage battery in multiple to feed the machine circuits and indication lamps. At the office and at JB Cabin carrier location, the battery operates tuned alternators for standby in case of a.c. power failure.

The track circuits are of the d.c. type with 4-ohm relays on those which are less than 1,000 ft. long and 2-ohm relays on those which are more than 1,000 ft. long. At locations where a.c. power is used for other purposes, track circuits connected at such locations are fed by a single cell of nickel-iron storage battery on floating charge from a rectifier. At other locations where track circuits exceed 5,000 ft. in length, high voltage 500-a.h. primary cells connected in multiple are used. Other primary batteries for operating track circuits are of the standard voltage type.

Underground Cable

Multiple conductor No. 9 underground cable was used for switch controls, while multiple conductor No. 14 underground cable was used for switch indication circuits. A junction box is located three feet above the base of mast on two-unit signals. Nine-conductor No. 9 underground cable was run from instrument case or house to junction box on the signal mast, with No. 14 flexible insulated wire extending up the mast to the signal heads.

For track connections, single-conductor solid No. 9 cable extends to a channel iron bootleg with an insulated terminal post mounted near the top of the riser. From this terminal, two insulated No. 9 stranded conductors extend to a plug terminal in the rail.

This signaling project was planned and constructed by signal forces on the Chesapeake and Ohio.