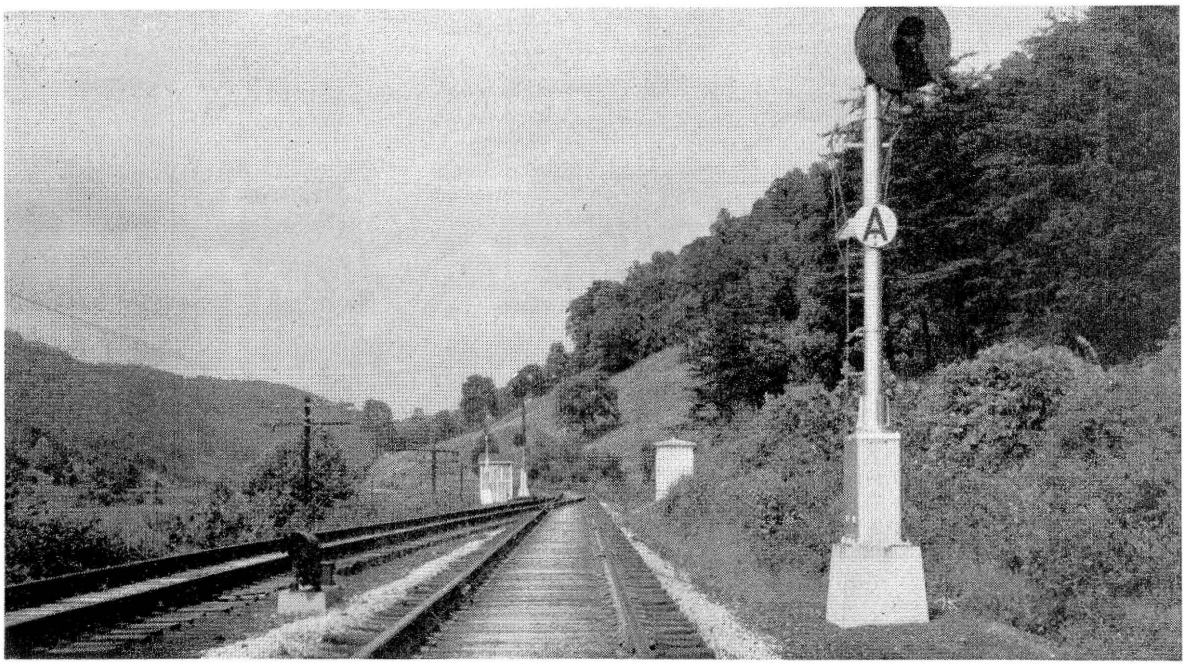


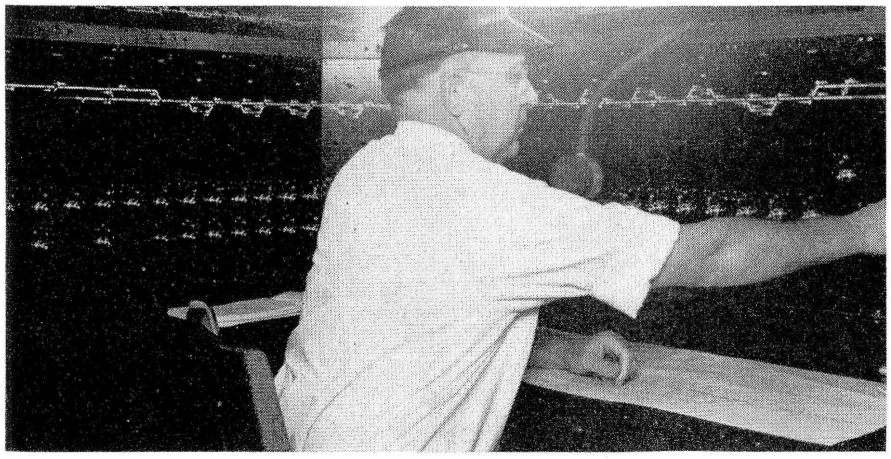
End of a typical C.T.C. controlled passing track showing station-leaving signals in the foreground. All signals on this project, except dwarfs, are approach lighted

L. & N. Extends C.T.C. on "EK"

Installation, which includes several interesting features, increases safety and expedites heavy tonnage trains on 106 mi. of single track and 18 mi. of double track serving big coal-mining area on road's Eastern Kentucky division

A NUMBER of unique and interesting features, not heretofore used in C.T.C. installations on the Louisville & Nashville, are included in an installation of signaling for the direction of train movements by signal indication on 106 mi. of single track and 18 mi. of double track between Ravenna, Ky., and Blackey, on that road's Eastern Kentucky division. The control machine is located at Ravenna, the north end of the territory.

New features of the project include: (1) coded carrier line control; (2) special indicators on certain signals in C.T.C. territory, controlled by the dispatcher to indicate when hand-operated switches are to be thrown by trainmen; (3) joint control of certain signals from the C.T.C. machine and an interlocking machine in the territory; (4) multiple-connected approach relays on coded track circuits for control of approach lighting and pick-up of directional-stick relays at intermediate locations; (5) two track resets, employing retained-neutral relays, in control of approach stick relays for facing-point direction towards ends of controlled power sidings and associated entering signals; (6) approach lighting of all signals, except dwarfs; and (7) use of three line wires between ends of sidings, plus retained-neutral relays between ends of controlled sidings to obtain the approach lighting.



The control machine for the C.T.C. territory is located at Ravenna, Ky.

Extension of 1943 Project

The installation, the total cost of which was approximately $1,000,000, including track and signal work, is an extension of a similar project completed in 1943 to reduce train delays and improve safety on 26 mi. of single track between Winchester, Ky., and Irvine, about a mile north of Ravenna (see page

524, October, 1943 issue). Double track is in service in the territory between Ravenna and Pryse, 6 mi., and between Perritt and Typo, 12 mi. The balance is single track.

The line on which the new C.T.C. has been installed serves extensive bituminous coal fields in Kentucky's Letcher and Perry counties, being fed by a number of branches which extend into mine areas. These include the Lots Creek branch at Hazard; Davidson branch; Lothair; Carrs Fork branch, Jeff; Leatherwood branch, Dent; and the Rockhouse branch out of Blackey. There are about 100 mines alone between Yerkes and McRoberts, 67 mi., and additional spurs are continually under construction to reach new fields.

Commencing at McRoberts, which is in the southeastern part of the state, as shown in the map, Fig. 1, the line follows the north fork of the Kentucky river for 123 mi. to Beattyville. From Beattyville, it continues 33 mi. northwest through the valley of the river to Ravenna, thence, out of the valley and onto a plateau into Winchester. At this point, the line connects with L.&N. main lines to Louisville and Cincinnati.

The line as a whole was planned and constructed for handling heavy tonnage trains northbound and return of empty coal cars to the mines southbound. While there are numerous curves, the maximum of which is 10 deg., and most of which are located south of Hazard, 30 mi. north of Blackey, the line between Ravenna and Blackey is at river grade, except between Oakdale and Gentry, 7 mi., where the maximum ascending grade is 1 percent northbound and 1-¼ per cent southbound. This is a helper district for all tonnage trains, and the onlv such district in the new C.T.C. territory.

130-Car Loaded Coal Trains

One local passenger train is operated in each direction daily. In addition, forest products and oil are moved northward but, for the most part, the freight traffic consists of coal. When the mines are operating normally, about 1,050 coal loads are moved northward daily, and approximately the same number of empties returned southward. The busiest period on the line was between May 24 and 30, 1948, when 982 cars of coal were loaded at the mines daily except Sunday.

Coal cars assembled from mine runs are made up into trains averaging approximately 130 cars each in yards at Neon, Hazard, Crawford and Ravenna. About 90 per cent of these trains are routed through Ravenna to Winchester and thence to Cincinnati. The remaining 10 per cent out of Ravenna are routed via Winchester to Louisville. Trains of empty hoppers returning to the mines average around 160 cars per train.

Table of Car Capacities of C. T. C. Controlled Passing Tracks Between Ravenna, Ky., and Blackey, L. & N. R. R.

Location	Number of Cars
Evelyn	123
Willow	112
Heidelberg	164
Beattyville	121
St. Helens	113
Oakdale	125
Yeadon	110
Gentry	124
Jackson	141
Haddix	123
Whick	128
Altro	118
Combs	57
Edjouet	153
Coolidge	118
Dent	107
Blackey	151

The tonnage trains in the new C.T.C. territory are handled by Class M-1 steam locomotives, which carry 25 tons of coal and 22,000 gal. of water in their tenders. They are capable of handling 9,500 gross tons and, with booster, have a tractive effort of 79,390 lb. Six-thousand horsepower Diesel-electric road locomotives are used in pusher and double-heading service in the helper district between Oakdale and Gentry.

Some Signaling Before

Prior to the installation of C.T.C. between Ravenna and Blackey, train movements were governed by time table and train orders, no automatic block being in service, except for short sections between Oakdale and Jackson, about 10 mi., and for about 16 mi. on double track between Perritt and Combs. Tunnel-protection signals were in service at Dumont tunnel, between Jackson and Haddix; Line tunnel between Altro and Perritt; and Combs tunnel, between Hazard and Lothair.

The new signaling includes controlled signals and power switches at the ends of 17 passing tracks, which are an average of 5 mi. apart, as well as electric locks on all main-line hand-throw switches. Because of considerable switching in the make up of northbound coal trains and the handling of empty hoppers southbound at Hazard, the signals,

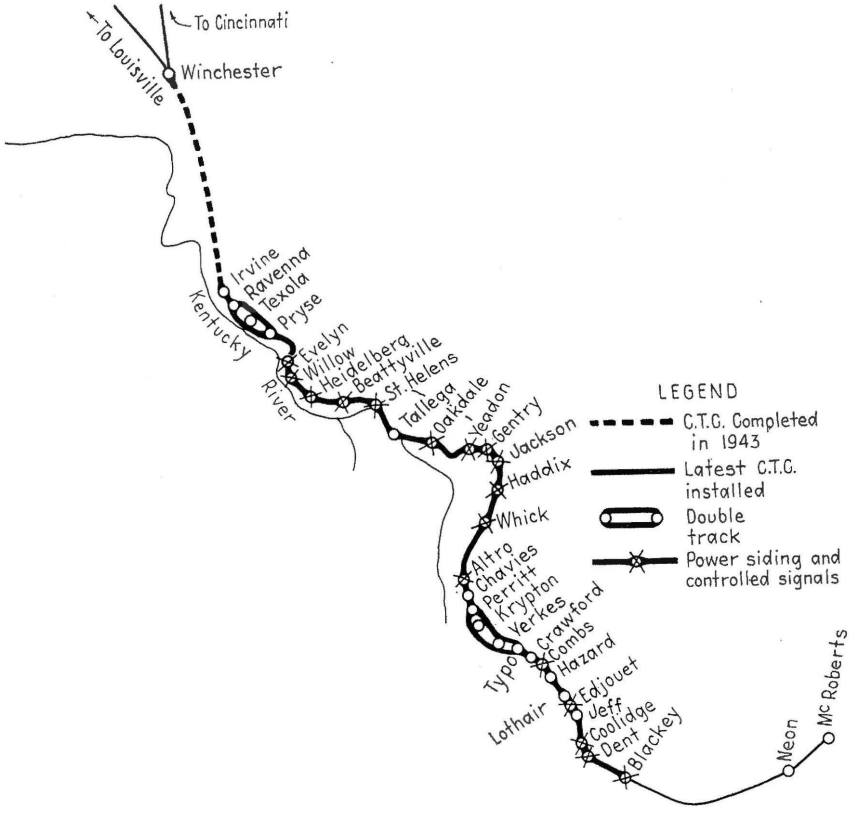


Fig. 1—Map of the C.T.C. territory

power switches and electric locks on hand-throw switches in that area are controlled from a separate interlocking machine in the yard office. As a part of the project, the former northbound main track between Combs and Typo, about 3 mi., was discontinued and converted into a siding. Automatic block previously in service on this track, however, was retained in service for protection of northbound train movements on the siding. A total of 14 block offices were closed after the C.T.C. was installed. These included Texola, Heidelberg, Beattyville, Tallega, Oakdale, Gentry, Jackson, Haddix, Whick, Altro, Krypton, Hazard, Lothair and Jeff.

In order to minimize the number of electric locks required on main-line hand-throw switches, and to straighten out the main line at St. Helens and Heidelberg, the main line was converted to the siding and the siding made into the main line. Prior to these changes, a number of spurs lead from the main line. In addition to the C.T.C. facilities, modern automatic short-arm electric gates and/or flashers were installed at several highway grade crossings in the territory, such as at Beattyville and Oakdale. These are the Transport Product Corporation's Model-8 assemblies, designed for operation on 10 volts d.c.

Some Trains Save 4 Hr.

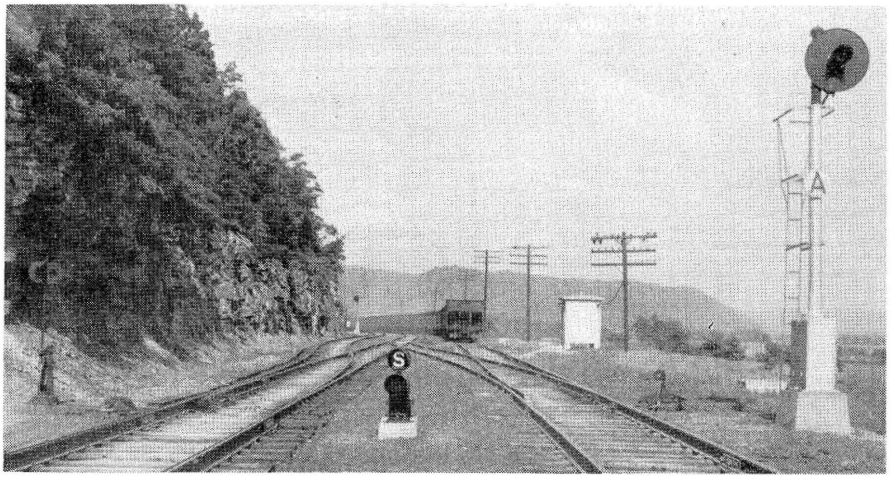
Under the previous method of operation, delays were incurred by trains waiting for orders, meets, changes in orders, etc., with tie-ups often resulting. In comparison, under C.T.C., the running time of through trains now averages 11½ hr.—a saving of 4 hr.—which effects considerable savings in locomotive water and coal consumption. The running time for southbound trains is approximately the same; while these trains are lighter, numerous set-outs of empty hoppers are made at mine spurs and branches enroute, thus consuming time. The speed limit for all freight trains is 40 m.p.h.

Heretofore, through northbound trains between Neon and Ravenna made water stops at Blackey, Hazard, Whick, Jackson (coal also) and Heidelberg. These were formerly regular water stops for southbound trains also. Through northbound trains with M-1 engines between Neon and Ravenna now only stop for coal and water at Jackson and for water at Jeff. These are now the only water stops made by through southbound trains, also. No coal is picked up southbound.

Northbound tonnage trains between Gentry and Oakdale are pushed over the grade and southbound trains are double-headed, 6,000-hp. Diesel-electric locomotives being used for this helper service. Northbound trains are stopped at Gentry for coupling the pusher locomotive behind the caboose, and the helper is cut off on the run at Yeadon, the crest of the grade about half way to Oakdale. Southbound trains are stopped at Oakdale, and the helper engine coupled ahead of the train. These trains are again stopped at Yeadon, and the helper uncoupled. The helper then proceeds behind the train to Gentry to help another train northward, or returns to Oakdale to help another train southward.

As a means of expediting northbound trains and getting under way again at Gentry after the pusher has been coupled and the train is ready to depart, the conductor at the rear end of the train pushes a button which lights a special information lamp on an instrument case near the north end of Gentry, indicating to the head end that the train is ready to leave. This action also lights a signal-request lamp on the C.T.C. machine at Ravenna, indicating to the dispatcher that the train is ready to depart. When another special information lamp on a relay case near the rear of the train is lighted, it indicates to the helper engineer that the leaving signal at the north end of Gentry has cleared and to shove slack against the head engine, thus indicating to the engineer of that engine to proceed. Under this arrangement of handling helper engines, and cutting same off on the run at Yeadon—a practice not heretofore followed, approximately 25 min. are saved by each train.

Construction practices and procedure on this installation were practically identical to those followed on other recent L.&N. C.T.C. jobs (see page 782, December, 1947 issue). The C.T.C. machine at Ravenna and the new interlocking machine at Hazard include the conventional arrangement of levers, track diagram and indication lamps, and the operation thereof is similar to that of machines on other installations.



Signals at Cow Creek, near Ravenna. Note lighted "S" indicator on dwarf

The new signals are the General Railway Signal Company's Type-SA searchlight, designed for operation on 10 volts d.c., and located in the usual way at the ends of sidings. Intermediate signals between the sidings are spaced an average of two miles apart and, in a few instances, such as between Beattyville and St. Helens, 3.6 mi., and between Gentry and Jackson, 2.8, there are no intermediates because of the short distances. Signaling between these points was treated in the conventional manner, employing "double yellows" on the first signals in approach to head block signals.

The intermediates in each direction between sidings are controlled by a two-wire polarized line circuit, similar to that explained on page 527 of the October, 1943 issue. Likewise, coded track circuits are used on the project, except on OS and electric switch lock release sections and short track circuits over highway crossings, and elsewhere in congested areas where the track circuits are broken up into short sections. Employing 75 and 180 code, coded track circuits in single-track territory are used only for detection of track occupancy and control of the two block

lamps for each siding-to-siding block on the C.T.C. machine track diagram. In the double-track territory between Ravenna and Pryse, they are also used for the control of signals, 75 code being used for Approach and 180 for Clear. These coded track circuits average 7,000 ft. in length, and the operation is similar to that explained in the article referred to above.

Swivel-Type Front Rods

The power switch turnouts at the ends of sidings are No. 12's with 22-ft. points, G.R.S. swivel-type front rods being used. The new switch machines are the Model-5D dual control, for operation on 24 volts d.c. The electric locks on hand-throw switches are the Model 9A, designed for operation on 10 volts d.c.

At the end-of-double-track layouts at Pryse, Perritt and Typo, No. 16 spring switch turnouts with 30-ft. points and roller bearings on the points are in service. These layouts are good for train speeds up to 35 m.p.h., thus enabling trains to proceed with little reduction in speed.

Code Line in Two Sections

The C.T.C. code line is divided into two sections: (1) Ravenna to Typo, 94 mi.; and (2) Typo to Blackey, 31 mi. Controls and indications in the first section are handled in the conventional d.c. manner over the two-wire line circuit by the General Railway Signal Company's Type-K, Size 10, Class M System. The controls and indications for the second section are handled in a like manner, but these functions are superimposed in the form of carrier currents upon the centralized traffic control line wires used for the first section between Ravenna and Typo, and converted to d.c. at the latter point and vice versa. Frequencies of 17 kc. and 13 kc. are used for controls and indications, respectively.

At the control office in Ravenna, a separate stepper unit is used for each C.T.C. section, and the stepper unit for the carrier-controlled section is connected to the line through carrier equipment consisting of: (1) a control transmitter for sending out control codes; (2) indication receiver tuned to the frequency of the transmitter at the converter location for receiving indication codes; (3) second transmitter and receiver for stand-by; (4) transfer relay for transferring from one transmitter-receiver combination to the other, changeover being made by operation of a switch on the control machine; (5) receiver relay for application of indication code impulses to the stepper unit; (6) power-off relay for automatically connecting d.c. to the filament of the transmitter and receivers in the event of a.c. power failure; and a filament transformer for supplying 26 volts a.c. to the carrier units. This apparatus is sheltered in a sheet-metal cabinet near the control machine in the dispatcher's office. Similar carrier equipment is in service at the converter location at Typo, the apparatus being sheltered in the C.T.C. bungalow.

As part of the project a telephone circuit for maintenance use was superimposed on the code line, a voice-actuated relay being in service at Ravenna, which controls a buzzer to indicate to the dispatcher when he is being called. This circuit by-passes the carrier converter equipment at Typo through a voice-pass filter.

"S" Indicators on Signals

Trains running with the current of traffic on the double track between Perritt and Typo are governed by automatic block, and crews of trains moving between these points are required to contact and secure permission from the dispatcher at Ravenna before making a crossover movement from one main track to the other, except at signal 2262. As shown in Fig. 2, this signal is equipped with two heads, between which is a normally-extinguished lamp unit with a white letter "S" in it. Northward trains finding this signal at Stop and displaying the "S", stop and open the hand-throw crossover, after which the signal clears to Restricting, authorizing the train movement through the crossover, and against the current of traffic to the northward dwarf signal on the southbound main at Perritt.

Similarly, at the south end of Combs, between the main line and the northward siding, the northward and southward signals are equipped with "S" indicators to

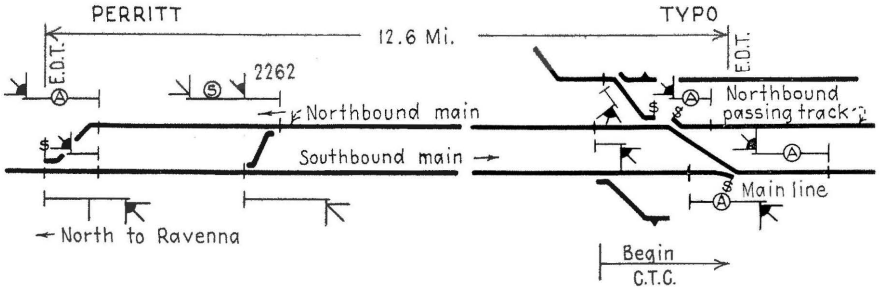


Fig. 2—Track and signal layout between Perritt and Typo

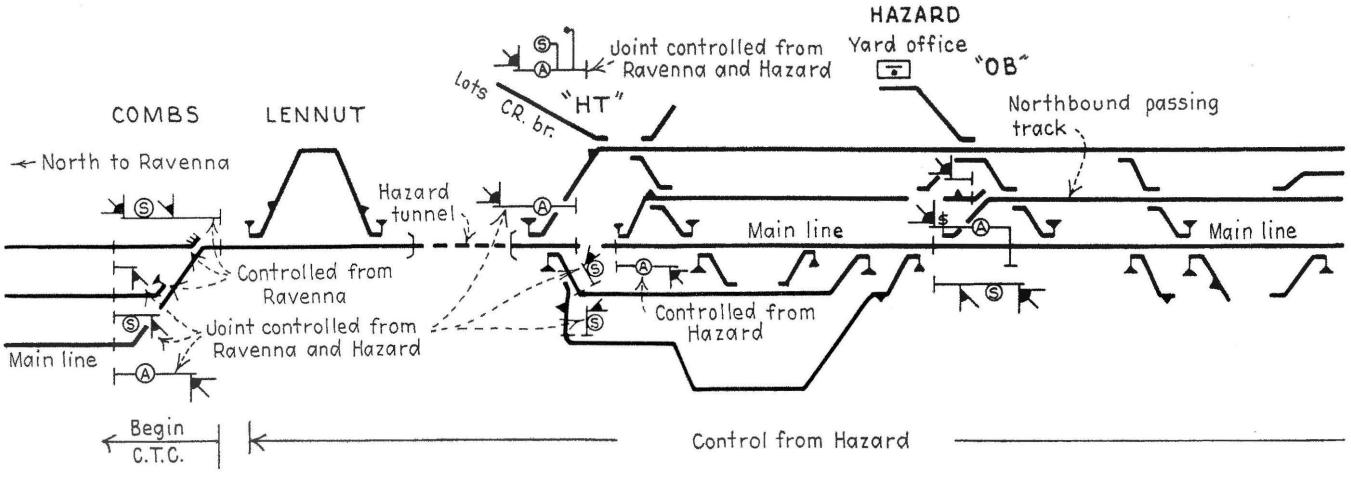


Fig. 3—Layout of the tracks and signals, includ-

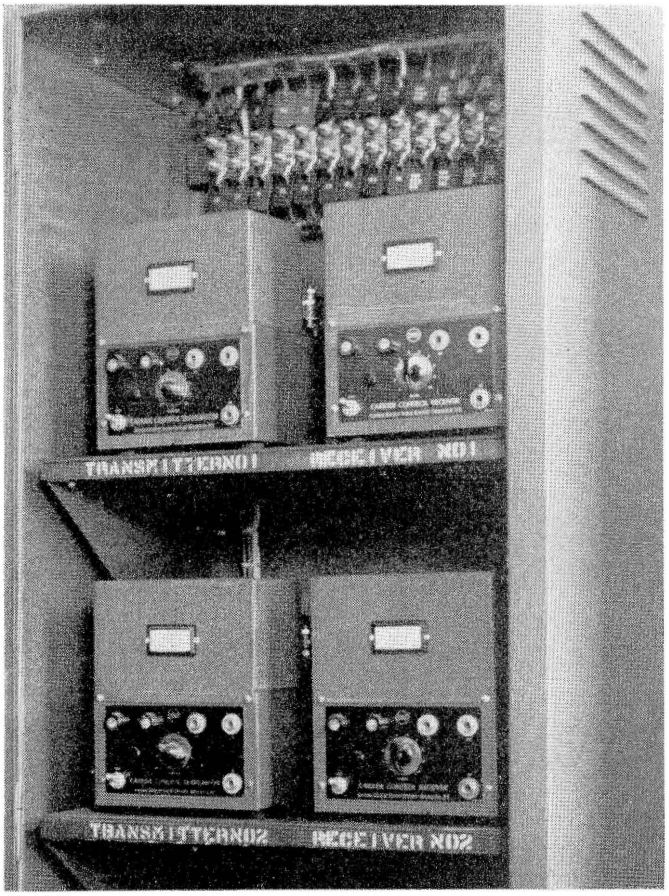
authorize opening of hand switches. The southward signal at "OB", in the center of the layout at Hazard is likewise equipped with an "S" indicator, which is lighted when trains are to head in the northward siding at that point.

Joint Control of Signals

Signals, power switches and electric switch locks between the end-of-double track at the south end of Combs, through Hazard yard, and the north end of the power siding at Edjouet, 5.5 mi., as shown in Fig. 3, are controlled from a new miniature lever type all-electric interlocking machine in the yard office at Hazard. As a means of coordinating control of these functions with the C.T.C. system, certain signals are jointly controlled from Ravenna and Hazard—the first time such practice has been followed by the L.&N.

The southward signals at the south end of Combs and the northward signals at "HT", the north end of Hazard, are so controlled. The signals at Combs cannot be cleared from Ravenna without lever consent from the machine at Hazard, thus enabling Hazard to hold out a southbound train if it is not ready for the movement. Similarly, the signals at "HT" cannot be cleared from Hazard without lever consent from the C.T.C. machine at Ravenna, thus preventing Hazard from letting a train out on the main line unless the dispatcher is ready for the movement. The same thing applies to the southward signals at "BG", the south end of Hazard, and the northward signals at the north end of the power siding at Edjouet.

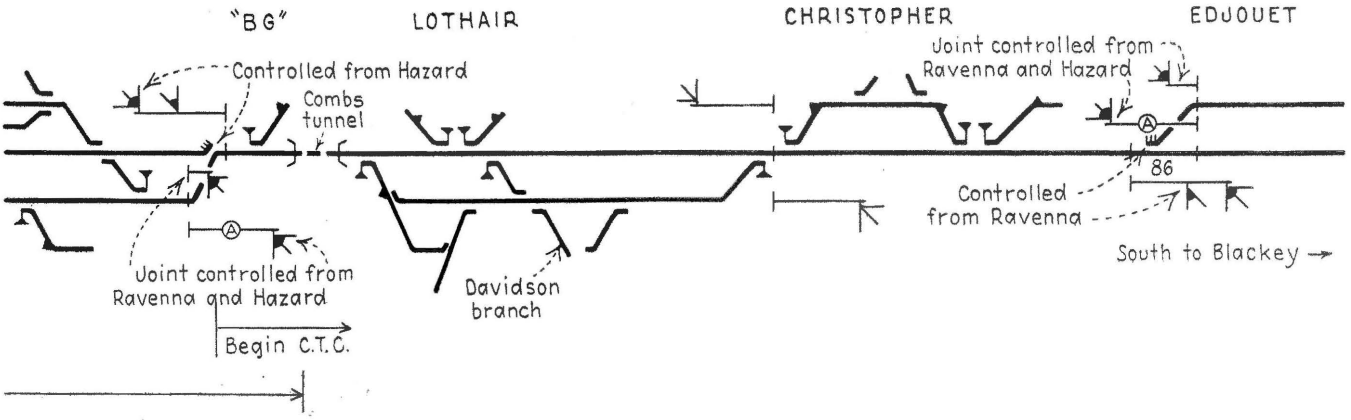
None of the electric switch locks between the south end of Combs and the north end of Edjouet are equipped with emergency release, as are electric locks elsewhere in C.T.C. territory. None of the locks can be unlocked from the Hazard machine without a lever request for unlock from the lock location.



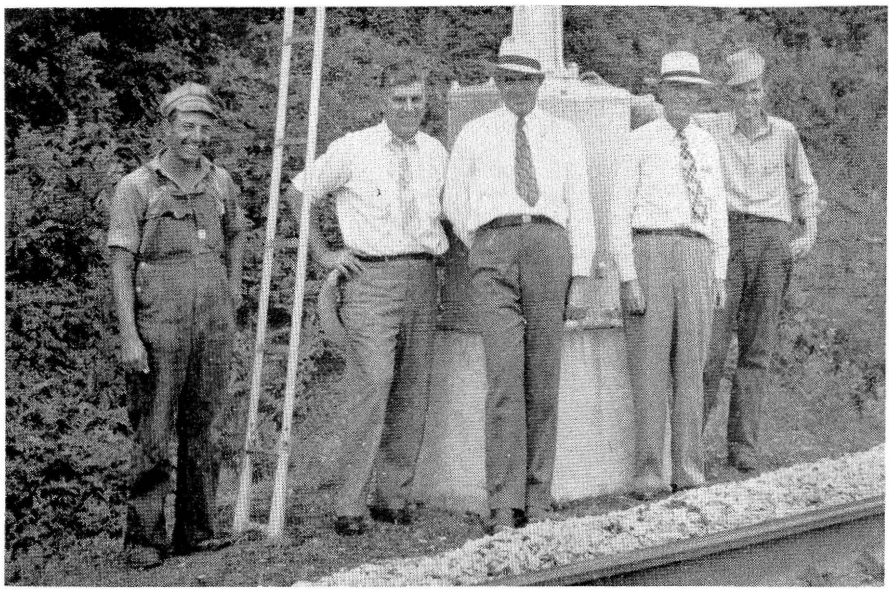
Carrier control transmitters and indication receivers at the C.T.C. office in Ravenna. One set is for standby use

Special Information Signals

At Jeff, the Carrs Fork branch enters the main line. A highway crosses both of these lines at this point, and provisions were required to prevent trains on the branch from blocking the crossing in the event the dispatcher is not ready to let them out on the main line. Consequently, there is a special repeater signal on the branch just south of the crossing. If the dwarf signal at the end of the branch has been cleared, then the repeater signal displays a white light, indicating to the train to proceed down to the dwarf; otherwise the repeater is dark. If a train approaching the indicator finds it dark, a member of the crew pushes a button thereon, which sounds a buzzer and lights a lamp on the control machine at Ravenna, indicating to the dispatcher that the train is ready to pull out. Such an arrangement is also in service on the Rockhouse branch at Blackey. Similarly, when a northbound train is to enter the main line at "HT", the north end of Hazard, from a yard track, a button at the respective northward signal is pushed, to notify the operator in the yard office that the train



ing Hazard interlocking, between Combs and Edjouet



Left to right at signal location — M. Clemons, Jr., signal maintainer; J. F. Wiseman, assistant signal supervisor; W. H. Smith, signal supervisor of train control; G. H. Hume, signal supervisor; and E. Benson, signal helper

is ready to proceed. If the operator is ready for the movement, a letter "S" on the signal governing the movement is lighted, authorizing the switches to be lined and movement made when the signal has cleared. When northbound or southbound trains are ready to leave the siding at Dent, a button is pushed at the end of the siding from which the train is to leave, thus indicating to the dispatcher at Ravenna to clear the dwarf signal if the route is clear and he is ready for the movement.

Multiple Approach Relays

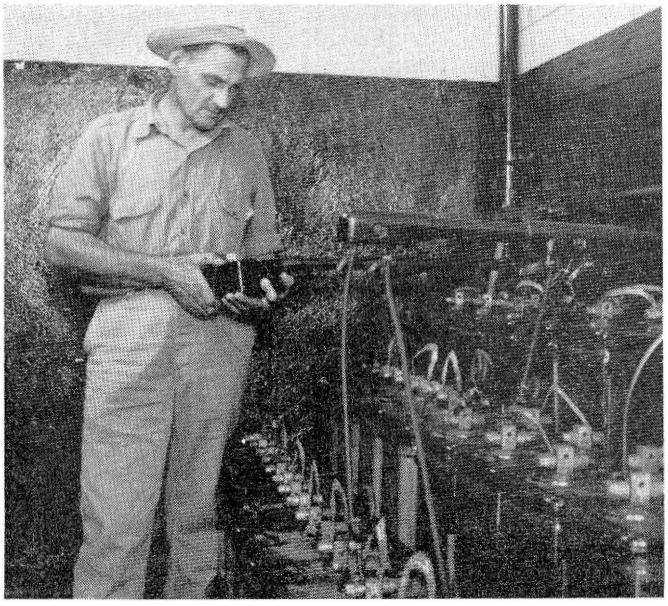
As mentioned previously, one of the new features of this project is the use of multiple-connected approach relays on the coded track circuits for the control of approach lighting and pick-up of directional stick relays at intermediate signals which are at the battery end of a track circuit. These are Type K 0.60-ohm code following relays, connected across the track battery at the rails with a 0.65-ohm and 7-ohm variable resistance in series with the circuit, which drops when track code is shunted within 4,000 ft. of the relay location. The actual control of the directional sticks and approach lighting being through a special slow-release repeater relay of the multiple approach relay.

Heretofore, in coded track circuit territory on the L. & N., approach lighting and control of the directional sticks at intermediates which are at the battery end of a track circuit have been through series approach relays. The purpose of this new arrangement is to have a more efficient circuit which is easy to maintain in adjustment.

Another new feature of this installation, also mentioned previously, is the use of two track resets in the control of approach stick relays. The AS relay of the station-leaving signal is reset by taking the circuit through the OS track and the first track beyond the station-entering signal de-energized. The AS reset of the station-entering signal is reset by taking the circuit through the OS track and a retained neutral HD relay de-energized or in other words through the OS track and the first track beyond the station-leaving signal. On previous L. & N. installations, control of these particular AS relays has been taken through only the OS track. The purpose of the two track resets is to prevent the AS relay from being reset due to a temporary shunt being applied to the OS track by track maintenance forces working within the OS section or a motor car with faulty insulation passing through the OS section. The AS relay having been reset, the dispatcher could clear an opposing route without the proper time delay. There would also be the dangers of an emergency stop being made by a train which had already accepted a clear signal.

All Signals Approach Lighted Except Dwarfs

At one time, all signals in C.T.C. projects on the L. & N. were continuously lighted. On later installations, however, in order to conserve battery this practice was changed, and continuous lighting was limited to controlled signals only, approach lighting being provided at intermediate signals. In 1947, on a 137-mi. C.T.C. installation between Louisville, Ky., and Henderson, approach lighting was extended to the controlled station-entering signals at the ends of power sidings and, on this project between Ravenna and Blackey, it has been extended to the controlled high station-leaving signals at the ends of power sidings. Thus, all signals are approach lighted except the dwarf signals.



Leading signal maintainer R. Weathers checks storage battery cells at Ravenna, Ky.

In order to obtain approach lighting on the controlled high signals at the ends of sidings, an additional line wire and retained-neutral relays were installed between the ends of sidings. The circuits are,

otherwise, similar to those on previous L. & N. installations, in which two wires were used between the siding ends.

Twelve cells of Exide DMGO-9 storage battery are in service at each power-switch location for operation of the switch machines, and five cells of Exide DMGO7SR battery are in service at each signal location for lighting and circuit operatioin. Each track circuit, with few exceptons, is fed by one cell of Edison 74-ah. B4H storage battery. A few short release section track circuits at electric switch lock locations are fed by Edison 1,000-ah. caustic-soda primary battery. The code-line battery at Ravenna consists of 50 cells of Exide BTMP-3 storage battery, that for the carrier equipment 12 cells of 280-ah. EM-15, and that for operation of the control machine 12 cells of 200-ah. EM-11.

Code Line Wires

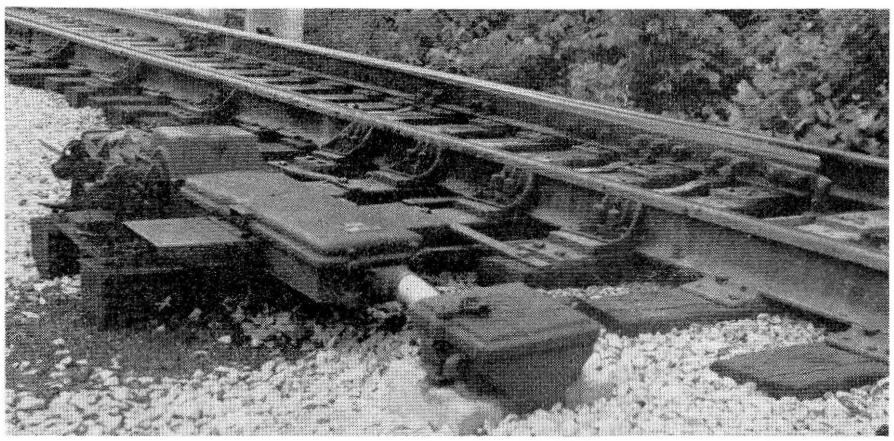
The C.T.C. code line is on two bare No. 6 solid copper line wires between Ravenna and Perritt, and on two plastic-insulated No. 6 Copperweld wires between the latter point and Blackey. The 550-volt a.c. power circuit on the pole line is on two No. 6 bare solid copper wires, and the low-voltage signal line circuits are on No. 10 bare solid copper wire. This wire was furnished by the Phelps-Dodge Copper Products Company and the Copperweld Steel Company. All signal circuits are tied to No. 42 Western Union standard glass-type insulators. Power circuits are on brown porcelain-type insulators.

The track in the territory is 132 lb. with rock ballast, the rails being bonded with the L. & N.'s standard 9-in. rail-head type bonds, which were furnished by the Ohio Brass Company, American Steel & Wire Company, the Erico Products, Incorporated, Hanlon & Wilson Company, and the Acme Railbond Engineering Company. The apparatus at each signal and power switch location is sheltered in welded sheet-metal instrument cases and bungalows. At the south end of Whick these cases and bungalows were raised 5 ft. above normal as flood protection. The railroad crosses the north fork of the Kentucky river at this point.

Installation and Maintenance

This C.T.C. was constructed under the jurisdiction of W. H. Stilwell, signal engineer, by the regular signal construction forces of the railroad under the leadership of H. L. Petty, general signal construction foreman. The major items of signaling equipment were furnished by the General Railway Signal Company.

The territory is divided into six maintenance sections, which are under the supervision of Signal Supervisor G. H. Hume and Assistant Signal Supervisor J. F. Wiseman at Ravenna: (1) Irvine to Cow Creek; (2) Ravenna-Heidelberg; (3) Heidelberg-Gentry; (4) Gentry-Altro; (5) Altro-Edjouet; and (6) Edjouet to Blackey. Each of these sections is maintained by a maintainer and helper, with the exception of the Irvine-Cow Creek section, which is handled by leading maintainer R. Weathers, who also takes care of the control office equipment at Ravenna. The maintainers for the remaining five sections include, respectively, W. O. Jesse, V. D. Hill, J. Gaines, A. A. Powell and C. D. Wiseman.



Typical power switch machine layout

STACKABLE CARRIER

(Continued from page 162)

a top value which will not damage any of the components under these conditions.

Demodulation synchronization is achieved through the network connected to the primary of transformer PLT OUT. Received pilot frequency, filtered in PLT REC and amplified in VB1, is fed through capacitor C8 to point DS where it is connected to the associated demodulator. Signaling frequencies are extracted from the input of filter PLT REC and routed through terminals 15 and 16 to the signaling equipment associated with the channel. Sideband frequencies are provided to the voice terminal at numbers 12 and 14.

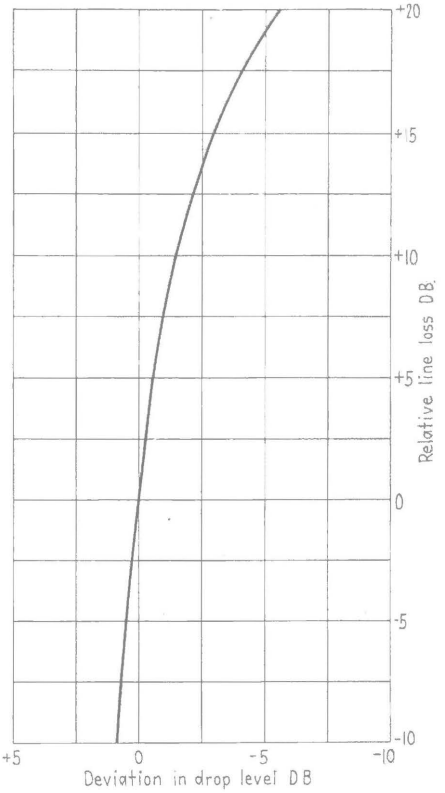


Fig. 10—Typical regulation curve for one Type-33 repeater section

The pilot-regulator unit also contains a pilot-frequency transmitting circuit, shown at the lower right of Fig. 9. Pilot current is secured from the modulation oscillator of the related voice-terminal unit and brought to point MS from where it passes through a switch, attenuator PLT PAD, and filter PLT TRANS FLT to the HF line. The switch permits removing pilot frequency from the common HF line for measurement of other levels. Resistor R14 bypasses the pilot signal to B minus when it is not being transmitted.